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ABSTRACT

The growing competition between higher education, other levels of education, and other sectors of the economy for limited government funds has made the need for more systematic methods of planning and management of higher education systems and institutions of utmost importance. This document presents a report of a conference whose purpose was to explore the experiences of various university groups in the development and testing of university management techniques. The introductory session focused on a general discussion based on the following areas: stress in higher education, and the concept of the university. This was followed by six presentations of university experiences in the application of management techniques, three from North America and the three others representing European work. This report is based on the conference papers. A list of participants is also included. (Author/PG)

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university planning and management techniques

by
GEOFFREY LOCKWOOD

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INTRODUCTION

The growing competition between higher education, other levels of education and other sectors of the economy for limited government funds has made the need for more systematic methods of planning and management of higher education systems and institutions of utmost importance. This need is further underlined by the rapidly growing number of students in higher education and the current crisis which higher education has been undergoing in most Member countries.

Recently, techniques of systems analysis have been successfully applied to some of the problems of resource allocation in higher education institutions. However, the extent of the role which can be played by the systems approach to educational planning is still in the stage of exploration and much significant experimentation in this field has not yet been fully evaluated and disseminated.

To this end, the Directorate for Scientific Affairs of the OECD organised a Conference on University Planning and Management Techniques as part of the programme of the Committee for Scientific and Technical Personnel. The Conference, which took place in Paris on 21st-24th April 1969, brought together experts and representatives from Member countries to discuss common areas of interest and to assess the state-of-the-art concerning quantitative planning and management techniques in institutions of higher education.

The central purpose of the Conference was to explore the actual experiences of various university groups in the development and testing of university management techniques. The emphasis of the Conference was on the problems of application of management techniques to actual situations in the universities. The participants were asked to address themselves to the following issues:

a) Are the techniques really implemented successfully as an administrative policy-making tool, or do they appear

successful only because of excellent marketing of the idea? Since these quantitative techniques are meant to aid university administrators in the making of policy, successful implementation should be given priority.

b) Are there political problems facing quantitative planners, university administrators and academic staff? How can these be overcome?

c) Should the theoretical techniques or the necessary accompanying data systems be developed first?

The introductory session focussed on a general discussion of these issues, which were based upon the following papers:

"Rationality under Stress in Higher Education" by Charles J. Hitch, President, University of California; "The Concept of a University; An Idealised System Versus Social Reality" by Abdul G. Khan, OECD Secretariat.

This was followed by six presentations of university experiences in the application of management techniques, three from North America and the other three reflecting European work:

- "Planning and Analysis in the University of California" by F.E. Balderston, Vice-President, Planning and Analysis in the Office of the President, University of California.
- "Systems Analysis for Efficient Resource Allocation in Higher Education. A Report on the Development and Implementation of CAMPUS Techniques" by Richard W. Judy, Jack B. Levine, Richard Wilson and Steven I. Centner, University of Toronto.
- "University Information System (UIS) for the Federal Republic of Germany and West Berlin" by Waldemar Krönig, Stiftung Volkswagenwerk.
- "University Administrative Data Systems" by Carl Roessler, Yale University.
- "Institutional Management and Planning Techniques at the University of Sussex" by Geoffrey Lockwood, Planning Office, University of Sussex.

- "University Planning: A Simulation Approach" by Nicholas O.A. Bullock, Peter G. Dickens, Philip Steadman and J.C. Gray, University of Cambridge.

Each presentation was discussed by a selected expert and followed by a discussion from the floor.

In addition, three working groups were organised. One group discussed optimisation models for university planning, another group discussed costs and efficiency in university planning and the third group, aspects of university governance.

The present report, prepared by Geoffrey Lockwood of the University of Sussex, is an attempt to make available to a wider audience the substance of the experiences and issues taken up at the Conference. It is based essentially on the Conference papers listed above, and the Secretariat wishes to acknowledge its debt to the various authors who contributed these papers.

CHAPTER 1

PROBLEMS AND OPPORTUNITIES

The problems, challenges and opportunities now being thrust upon universities in all countries of the world are the essential background to any discussion of institutional planning and management techniques. Many books have already been devoted to these problems and the majority of those who read this report are likely to be aware of most of the issues. Nevertheless, it is necessary to summarise those issues before proceeding to discuss the management of universities.

The problems and issues are interrelated and their interaction adds to the complexity of the situation facing universities. However, separate types of problems can be delineated for descriptive purposes.

The first is the basic problem concerning the role of the university. The roles of most universities have gradually been transformed over the past fifteen years, mainly through external stimuli and normally by piecemeal change with little serious discussion of the reasons and alternatives. The scope of that transformation is, itself, now leading members of universities to reflect more systematically and urgently upon the question of role. Three extreme views will serve to illustrate the issue. One view is that the role of the university is to provide a static island of learning in a troubled world; many members of faculty who would not regard themselves as subscribing to that view nevertheless exhibit attitudes and opinions which spring from it. A second view is that the role of the university is to change society, to create a new society and not to serve existing society; this is the view most frequently ascribed to students. A third view is that the role of the university

is to serve society according to the needs of society as expressed by its current representatives. Most members probably hold less extreme views which see the university as an organisation which has to provide the goods and skills required by existing society whilst remaining sufficiently detached and critical to be a key force for social change. The fact that the majority do not hold extreme views does not ease the situation greatly since the problem is one of resolving the balance of emphasis between roles rather than of agreeing upon a single role. This discussion illustrates the basic problem of institutional planning and management, since neither planning nor management can be fully effective in an institution which is divided as to its purpose. The group at the Conference which discussed aspects of the government of universities, and which was led by Professor G. Michaud of the University of Nanterre, concentrated on an analysis of the roles and natures of universities. The group realised that it was not possible in the time available to reach a consensus on such issues, but from the discussion of those issues the group posed questions about techniques and models of management. The group's questions centred on one theme: given the increasing rate of change towards democratisation, inter-disciplinary studies, continuing education, internal flexibility, etc., in universities, will the models now being developed facilitate adaptation to the whole range of those social, educational, cultural and economic changes, or will they inhibit changes other than those brought about by economic forces. It is hoped that this report will help others to formulate their answers to such questions.

The second issue facing universities is the explosion in the numbers of students in higher education. This issue requires little illustration: the average growth rate of university enrolments in twenty OECD Member countries was 8.3 per cent per annum over the ten-year period 1955-56 to 1965-66, and in most countries the projections of the growth in enrolments in the next ten years are equally high. Growth has occurred mainly through the expansion of existing institutions and thus the rate of growth has, directly and indirectly, presented problems of new dimensions in planning and management to those institutions. If the question of role is the basic one facing universities, growth in size is the issue which has forced that question to the forefront and which has re-orientated the internal and external relationships of universities.

Another problem is the ever present one of finance. Growth in size, which in many cases has been allied with rises in student unit costs and almost everywhere been added to by increases in research costs, has led to a vast expansion in public expenditure on universities. The consumption by the universities of an increasing percentage of national income has had many effects which have presented planning and management problems to individual universities. One set of problems relates to cost efficiency and the need to demonstrate that efficiency to the public and its representatives; space utilisation, instructional costs, student attrition and achievement, building costs, and many other aspects of university finance have all begun to be analysed much more closely, partly because of external pressures. Another set of effects concerns the accountability of universities to public authorities. The increase in public expenditure has led to a re-definition of the concept of public accountability in most countries; the opening of the accounts of British universities to scrutiny by the Comptroller and Auditor-General of Parliament provides an example. In essence, in providing increased income for the universities society is rightly asking for increased production from the universities and for more information on the workings of the universities. Another consequence of these developments is that within a university each set of members asks more of the other members; faculty asks more of students, administrators ask more of faculty, students and faculty ask more of administrators. Thus external stress is translated into internal stress which further complicates management and planning.

A fourth issue concerns the place of the universities in the overall system of higher education. In some countries, higher education has always been planned as a system; but in many countries it is only in the past few years that the concept of a planned system of higher education has begun to affect the development of the separate aspects of higher education. The fact that the managers of a university must increasingly see the university not as an isolated entity but as part of a co-ordinated university system, which is itself part of a planned higher education system, has important consequences for the internal planning and management of the university. To give a few examples, it means that the university must seek information on the aims of, and the trends in, the national system and

must use this information systematically in its own decision-making. It also means that the university must continuously check its own performance against the national plan and the performance of other parts of the system. The concept of a planned system also implies that the parameters for individual institutions will be narrower; the managers of a university will have to take into account the pressures for rationalisation, specialisation, economies of scale, regional co-operation, etc., which occur within a system.

A fifth area of debate concerns the teaching and curriculum of a university. Four factors can be mentioned to illustrate that curriculum design and development is a problem which now concerns the institutional manager as much as it does the academic faculty. First, the continuing explosion of knowledge combined with a fixed length of degree course (and, in some countries, a pressure to reduce the length of these courses) means that the problems have increasingly to be faced through a systematic institution-wide re-evaluation of curricula. Secondly, the extension of knowledge is lessening the rigidity of the boundaries between specialisms and subjects; most of the more interesting and relevant developments are occurring at the old borderlines. These developments need to be reflected in the teaching curriculum, and their inter-disciplinary nature requires an institutional approach to the problem. Thirdly, the authoritarian method of teaching is being questioned by an approach which views the process as one of learning rather than teaching. Similarly, the development of a technology of education opens up new concepts and techniques of teaching, learning and course design. Fourthly, the discussion on the role of a university is reflected in the concern over curricula; increasingly the call is for curriculum to be more "relevant". Curriculum has always been a battleground of faculty conflict; as President Hitch of the University of California has remarked, "more than one university curriculum looks more like a truce document than a programme for the salvation of man"(1). Now the conflict has widened. The fact that the call from industrialists and professional societies equates relevance with the needs of employment, that the plea from student groups is for curricula more

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1) "Rationality under Stress in Higher Education", the paper prepared for the Conference by President Charles J. Hitch.

relevant to contemporary social problems, and that other critics interpret "relevance" in different ways only serves to make the problems more complex without distracting from the validity of each viewpoint.

Issues concerning the internal government of a university present another range of problems. The problems are common to most large organisations in modern society and will be familiar to most readers. The following draws attention to some of the changes and trends which exercise the minds of all types of members of universities. Individual members feel unable to participate in effective decision-making and they strive to find ways in which the faceless organisation can be made to serve them instead of their serving it. Over-elaborate constitutional machinery gets by-passed in order that decisions can be made quickly. Thus informal decision-making structures are created in parallel with the formal structures. The concept of the university as a self-governing community of scholars is no longer appropriate: students are increasingly being given a role in the internal government of the universities; administrators have of necessity to play a more important and positive role; external agencies and members have considerable effects, either directly or indirectly, on internal government. Thus, the balance of power is shifting and becoming less easy to identify. Internal groups press for all kinds of governments varying from worker-control and direct democracy through representative systems to oligarchy and dictatorship. The difficulty of balancing faculty, student, administrative and lay participation and influence is complicated by the need to balance the forces of centralisation and de-centralisation. Many of the issues commented on above tend towards the concentration of control and initiative at the centre (e.g. the need to improve institutional planning to re-design curriculum across traditional boundaries), whereas the need of individuals to participate, and the answer to overloaded decision-making structures increasingly point towards the devolution of action and incentives as universities grow larger. The problems of internal government reflect "the deep uncertainty about two fundamental elements in the structure of the university - its economics and its politics. We really do not know just how the modern university should be paid for, and we are just beginning to

learn how and by whom its powers should be held and exercised"(1). Simplistic attitudes towards faculty and student rights, the role of administrations, and responsibilities of external agencies do not help in the search for new, and necessarily complex, solutions to these problems.

A sixth range of issues concerns the increasing size and costs of research activities in universities. Three issues will serve to illustrate. First, in terms of men and money it competes with teaching and there is thus a problem of balancing teaching and research within a university. Secondly, the need to gather research workers into ever larger inter-disciplinary teams supported by special services and equipment is no longer restricted to a few areas of science, and an individual university cannot hope to indulge in such research in all of the subjects it teaches. The university is thus faced with decisions as to the areas on which it should concentrate its research activity and the centres of excellence which it can create either on its own or in collaboration with other institutions. Thirdly, in order to conduct such research a university increasingly has to seek financial support from non-public sources and this creates another dilemma in that the internal balance of a university may be determined more by the relative availability of external funds than by internal priorities.

Many other problems could be mentioned. Universities now have to face the normal problems of large employers: the unionisation of labour forces, collective bargaining, labour utilisation and productivity. Universities now have to contend with public relations problems of dimensions which were unforeseeable even a few years ago, particularly since the public has gained more direct experience of universities and the news media have become more aware of their relevance and importance. The list of problems and challenges is almost endless.

However, one major factor needs to be emphasized. The above issues and changes would face university managers with considerable problems even if they were once-and-for-all changes; the fact that they are not is in itself critical. Universities exist in an

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1) George McBundy, Faculty Power, Atlantic, September 1968.

increasingly dynamic environment; the indications are that the rate of change will increase rather than decrease. Universities therefore need to devise management and planning structures which will encourage continuous internal adaptation to external change. The problem is even greater because university structures have previously been geared not to change but to the protection of the rights of individual members. The "ivory tower" concept is derided by most members of universities but the attitudes implicit in it persist strongly and widely; many faculties act daily on the assumption that a university is not a dynamic institution and that its members should not be subject to occupational and institutional stress.

In summary, the expansion in size, the rises in costs, the need to clarify roles and the increasing rate of change in the factors affecting a university have highlighted some of the most critical problems of management and planning. These problems provide challenges and opportunities which should be faced with vigour and imagination. It is conceivable that the Golden Age for some categories of members of universities lies in the past, but the Golden Age of universities as institutions of importance and relevance to all peoples surely lies in the future.

The typical reaction of a university has been first to regard these problems as unique, and secondly either to debate the problems or to ignore them. The belief that universities are unique, that they cannot share problems with other kinds of institutions and that they cannot learn from the solutions devised by other institutions is a deeply rooted one. The facts are that the universities are facing real problems, that a university has elements which differentiate it from other kinds of organisations but that the problems of universities are no greater and not of a different order from those faced by many other institutions, and that universities can learn from those institutions. The greatest obstacle to change in most existing universities is the belief of most of their members that the institution can change only at the margin. This is not necessarily the case. The second step in the reaction of a typical university represents a failure to understand or to recognise the role of management.

Management should be a process through which change is considered and implemented. Yet the very word "management" is still

shunned in most universities, partly because it seems to be equated with bureaucracy or autocracy and partly because of a belief that management has to be solely concerned with the profit motive. However, management is the people and structures involved in the decision-making process; its nature can be autocratic, oligarchic or democratic; and the assumption made by the author is that university management must be a democratic process. Cost/benefit factors or the concept of value for money can provide a basis for management in the absence of a profit motive. Universities produce outputs if not profits, and many management techniques can rely on input/output ratios rather than on profits (e.g. management by objectives).

In addition, the main aim of most management techniques is to make decision-makers aware of the alternatives open to them and the implications of those alternatives. The undoubted fact that fewer implications can be quantified in an educational institution than in most other forms of organisation detracts from the theoretical rigour with which certain techniques can be used, but it does not detract from the practical utility of those techniques when used by people who understand the nature of a university. It cannot be over-stressed that it is the systematic approach which brings the main benefit and which is open to all institutions. There are no packages of easily transferable techniques; each institution can learn from the experience of others but the particular techniques need very careful study before being adopted by an institution. Such techniques and sub-systems need to form part of the institution's overall approach to management.

The general approach to planning and management within the university can be summarised under five headings. First, it should be management of, and planning for, change; there is no alternative other than change, but this simple fact is not always reflected in the attitudes of university members. Historically, change within universities has resulted mainly from external stimuli, and changes in the external environment, whether they be in the realm of political policies or in the distribution of pupils' choices amongst subject preferences, are difficult to predict accurately. Planning within a university should therefore be a continuous process and not the rigid implementation of fixed plans. There is a difference between planning and plans and the former does not necessarily have to

result in the latter. Given that planning is a continuous process, the management system of a university needs to create devices for monitoring internal and external change; both in the external environment and in the internal performance of the institution there are critical indicators which register the need for change, and management should watch and use those indicators.

Secondly, management and planning should not be regarded as activities which can be separated from the other activities of the university (e.g. teaching, research). The university needs to be seen as an entity, its structures and processes designed with all its activities in mind; and, given that change is continuous, those structures and processes should be flexible. Planning is pointless if the university does not have the ability to change and is not presented with the opportunity to change. It is the task of management to maximise those two prerequisites for planning. If the university is to have the ability to change - and in time for the change to be effective - it has to keep its internal structures flexible; organisational boundaries, budgetary procedures, teaching methods, admissions and assessment practices, research programmes and all other ranges of activity need to be capable of at least marginal alteration or realignment at relatively short notice. Equally, the ability to change is not meaningful unless the institution has the opportunity to change. It is less easy to generalise about the opportunity to change since much depends upon the nature of the particular environment, but in most cases that opportunity arises from a low ratio of costs to benefits and from an accurate alignment of university activities to national needs. Most universities are heavily dependent upon public funds and it is these factors which should continue to attract these funds.

Thirdly, management and planning should not themselves be seen as separable activities. Efficient management requires perspective; daily decisions need to be taken in the knowledge of the direction and rate of change, and those daily decisions may then affect that direction and rate. Planning is part of management and it cannot be efficiently undertaken by staff who do not have knowledge and experience of the current workings of the institution. There should be no technical mystique surrounding planning. The fact that planning uses advanced techniques sometimes leads institutions to appoint

technical specialists as planners, sited in offices separate from those concerned with routine management. To do this is to misunderstand the nature of planning; planning is largely concerned with problems of human relations, and planners must, above all, enjoy the respect and confidence of the members of the institution. A planner should be a generalist with experience of management; his specialist background could be in economics, sociology, operational research, mathematics, accountancy or any other discipline. Equally, managers cannot regard planning as something that is done elsewhere in the institution by people different in kind from themselves. Managers and planners should be interchangeable over time though their specialist technical assistance may not be so.

Fourthly, management and planning in a university should be participative. A few years ago such a statement would have marked a difference between universities and other types of organisations and services. The statement would have been made on the grounds that universities were self-governing communities of equal scholars, in contrast to the authoritarian structures of industry and government. However, the difference is now less marked. The need for participation does not spring from the outmoded concepts which surround faculty self-government. The need exists because planning and management cannot be efficient or effective unless all parts of the institution, and representatives of all classes of members of the institution, are involved in the "concerted exercise of foresight". Not to encourage full participation, including that of students, is to limit the range of experience and knowledge which can be brought to bear on the problems and also to risk the goodwill and understanding of members which are necessary if they are to accept change. Participation should not be limited - as it so often is - to involvement in discussion. Provided that a framework is established for the interrelated functioning of the corporate institution, it is possible and desirable to delegate or devolve a large proportion of management and planning initiatives, decisions and authority, to sections and units within the university.

Finally, planning and management in a university should not be dominated by logistics, resource allocation and other quantitative factors. Most current planning in universities is concerned with topics such as unit costs, space utilisation, and faculty/student

ratios. This type of fiscal or logistic planning stemmed from public concern over the increasing costs of higher education; it is means-oriented and its design and functioning are largely in the hands of accountants. Yet it is a subsidiary form of planning. The major and fundamental task of planning is the definition of institutional mission and objectives; the second task is the setting of priorities amongst the multiple ends of a university. Only then do the means enter the process, and the means include such topics as teaching methods, faculty recruitment, admissions criteria, etc., as well as the logistic ones referred to above. There are signs that universities are now moving towards tackling these basic problems of planning. The fact that the external community and the students have begun to question institutional mission as well as institutional costs has helped motivate universities in that direction.

This book makes one basic assumption about the nature of universities: that a university is a democratic corporate entity possessing a collective identity and powers which integrate the activities of its parts. A contrary assumption that a university is solely the legal shield, an economic framework and a social community within which individuals and groups can exercise their academic rights or entrepreneurial freedom is the traditionally held assumption by many groups in universities.

The purpose of the book is to indicate the potential of management - in the widest sense of that term - by reporting on a number of case histories of universities. The opportunities and problems which face universities necessitate, and will lead to, more internal management and planning; the question is whether or not it will be better management and more effective planning. The choice lies squarely with each individual university.

We are concerned here with management and planning techniques. It should however be emphasized that planning is a subsidiary function of management. Planning is taken to mean the organisation of decision-making in the future as well as the collection and analysis of information relevant to such decisions and the eventual recording of agreed decisions in the form of plans. It is not intended here to cover all the relevant techniques. First, we are concerned with the planning and management of individual institutions and not with national systems; the distinction is not a desirable one but it is

necessary for reasons of space. Secondly, we are primarily concerned with quantitative techniques rather than the full range of systematic techniques of which the former is only a section.

Finally, no attempt is made to advocate particular techniques. With the exception of Chapters 1 and 8, the book reports on experiences in the use of management techniques as expounded by participants at the Conference. The author acted as rapporteur and no attempt has been made to analyse in depth the experiences reported. Any institution which wishes to give more detailed consideration to the experiences and techniques covered here should carefully examine how far the techniques have been fully integrated into the decision-making processes of the institutions concerned, what the costs have been and what actual benefits have resulted.

CHAPTER 2

THE PLANNING PROCESS AT THE UNIVERSITY OF SUSSEX

Having described the problems and opportunities of institutional management and planning for universities, this chapter outlines some ways in which the University of Sussex is attempting to apply management methods. The University of Sussex in the United Kingdom was founded in 1961; by 1969 it had an enrolment of nearly 4,000 undergraduate and graduate students. The following describes the salient features of its management and planning. It does not represent a model, but it does provide an example of an attempt to manage change.

The key decision in regard to the management of the University of Sussex was taken in its first year, i.e. that the organisation of the University should be reviewed annually in a structured sequence which involved the participation of the members of the University. This led to a concept of organisation in which the units, complexes and areas were seen not to be segmented and fixed but related, and their boundaries and the structure of their interrelationships changing, although patterns had to be fixed for one year at a time for reasons of organisational efficiency. The secondary beneficial effects of that key decision were that the organisation of the University had to be clearly described and explained to all members once a year, and that discussion about the organisation had to be concentrated into one sequence each year (thus saving the time and risks involved in the consideration throughout the year of specific proposals for change in isolated areas out of the context of the review of the interrelated whole). The Organisation of the University document is the result of each year's annual review, and copies are available to all members of the University. It consists of four parts: the nature of the organisation, the committee structure, the

officer structure and the planning process. The annual review also means that by small annual adjustments it is possible to make major changes over a period of years. Also, those annual adjustments and the openness of the process has meant that there is probably less of a gap at Sussex between the formal decision-making machinery and the real power structure.

The organisational structure of the University is summarised in the Charts on Committees and Management 1963-64, 1967-68 and 1968-69 contained at the end of this chapter (Annexes A and B). It is assumed that readers will be aware of the limitations of two-dimensional tree-charts; such charts can only select the main operating relationships out of the mass of cross-links and interrelationships, and they do not signify levels of status.

The charts have been included not in order to analyse them in depth and over time, but because they demonstrate in summary the value of a continuous review of structures. The first fact they illustrate is that considerable change has taken place. From the charts, however, it is easy to overlook the fact that a change of line or location represents a major shift in the duties, existence or authority of a unit, an officer, or a committee. The term organisational structure embraces both the units of organisation and the pattern of relationships which govern the activities of those units. The charts indicate that changes in both aspects have been made through time. In regard to the units, the main academic units of the University are the Schools of Studies. These multi-disciplinary, inter-disciplinary and overlapping Schools were an invention of the University created to reflect the teaching and research philosophy of the University; their nature and size make them more flexible and "open" than the normal basic academic unit (i.e. the single discipline department) and allows the University to develop through cellular growth. The University's ability to create new units to meet new problems or changing circumstances has not been diminished; the concept of the Vice-Chancellor's Office as the key co-ordinating and initiating unit was introduced in 1968. The merging of the traditional library with the units responsible for media services and audio-visual teaching aids into one Learning Resource Complex took place in 1969.

In regard to the pattern of relationships, the charts illustrate the ability to change the determinants of the boundaries. The 1963-64 pattern was based upon boundaries which are traditional in most English universities (divisions between "academic" and "administrative" duties). The basis of the boundaries can be seen to be changing in 1967-68 and to have changed fundamentally by 1968-69 to an "area" basis within which greater devolution of work and initiative can be fostered. Another factor is that an annual review helps to keep the system from being overloaded. As institutions develop, their structures tend to increase in complexity. The 1963-64 charts illustrate a clear pattern which became confused by 1967-68; in that year complexity was recognised and the 1968-69 charts illustrate that a clear pattern on a larger scale emerged from that review. Similarly, the charts show that between 1963 and 1967 the committee and the management structures grew apart, and the recognition of that fact through the annual presentation of a description led to a closer identification of the two structures by 1968-69. Also, a comparison of the 1968-69 charts with the descriptions of the processes which follow demonstrates that the units and the structures used for committee, management, planning and budgetary purposes are as identical as possible. Simple and obvious as that may appear to readers, it is far from unusual within a university that the building blocks of the governmental, academic and budgetary structures are each different. Finally, the charts illustrate that small marginal adjustments each year may result in major changes over a period of years without major upheavals in the system. For example, if it had been suggested in the period 1961 to 1964 that students should be members of the major financial and planning committees it is likely that the suggestion would not have been accepted, yet by 1968 students were members of these committees because they had proved the value of their membership to the University by their contributions to subsidiary committees on a rising scale each year.

The organisational structure of the University was supported by a variety of procedures and processes for decision-making which developed in the early years of the University's existence. In 1968 they were combined with the aid of McKinsey & Co. into one comprehensive Planning Process, partly to improve the co-ordination of plans by combining academic and financial plans, social and building

plans, etc. in each unit, and by processing the plans collectively through the committee structure; partly to systematise the setting of objectives by asking each School, Subject or other Unit to prepare a plan containing its recommendations of changes and ideas for improvement; partly to improve the timetabling of planning and make it continuous and partly to increase participation in planning. All members cannot participate equally and very few can participate in the total process, but everyone should have the opportunity to contribute to some aspect of the planning, and all aspects should be open to comment by representatives of all sectors of the University.

The planning Process is summarised in the charts at the end of this chapter (Annexes C, D, E). Since the process is a complex of systems with a cyclical pattern it is extremely difficult to describe simply, but the following are its main outlines. The five main elements of the process are:

Strategic Plans. Strategic planning is seen as the setting of objectives and the selection of strategies to meet those objectives, its primary focus being long term (4-6 years) to identify major issues and point to major decisions which will change the fundamental character and direction of the enterprise. In the context of the University it involves such issues as the long-term rate of growth, the balance between Arts and Science, the balance between undergraduate teaching, post-graduate training and research.

Operational Plans. Operational planning is seen as the translation of agreed objectives and strategic plans into specific action programmes over the short term (i.e. two-three years). In the University context, this involves such issues as the numbers of faculty and students, curriculum changes, re-allocation of space, etc.

Budgets. The budget is seen as the financial/numerical expression of the operational plan for one year ahead (e.g. financial budget, manpower budget). The budget at Sussex consists of a grid linking spending programmes and spending units (see descriptive charts).

Control Reports. For example, the Finance Office produces control reports and statements of expenditure for the major committees at stated frequencies throughout the year, and for each unit to show performance against budget. Other offices produce similar reports (e.g. Establishment Office in regard to manpower, the Admissions Office in regard to student numbers).

Information Flow. It is essential that the process is understood by members of the University and thus reference works on detailed aspects of the process are being made available (e.g. a Guidebook of Financial Procedures, a description of the University's Records and Statistics Systems, etc.). In addition, university and unit plans cannot be efficiently constructed unless information about internal and external factors and trends is made available, thus a network is being created along which information can flow to and through the Planning Officer from and to the persons concerned with teaching, research, admissions, examinations, appointments, health, accommodation, finance, space, educational technology, social policy, etc. It is also partly for that reason that institutional research is being attached to the Planning Officer and that the University's records are being computerised in order to build up an integrated Management Information System.

These are the elements of the process. The University is structured hierarchically into four main levels (see Chart of Planning Units, Annex E):

1. The University itself, represented by the Council, the Senate, the Planning Committee and the Vice-Chancellor;

2. Areas: the University is then divided into four main planning areas - Arts and Social Studies, Sciences, Social, and General;

3. Units: each of the four main areas consists of units (e.g. five of the Schools of Studies belong to the Arts and Social Studies area);

4. Sub-units: in turn there are sub-units of the units (subjects are sub-units of the Schools, the Admissions Office is a sub-unit of the Administration, etc.).

Each of these areas and units is required to produce a plan with the assistance and guidance of people external to the unit, principally the Planning Officer. The annual planning cycle (see Chart of Annual Flow, Annex F) is the flow of the elements of the planning process through those four main levels. In October of each year the Vice-Chancellor's Office produces revised versions of the elements of the planning process (strategic plans, operational plans, budgets related to each other by various formulas). The assumptions built into those revised versions are critical in that they provide

the framework within which the ensuing discussions take place. The annual planning assumptions are then considered by the Planning Committee and the Senate before being sent to level four (i.e. the sub-units) from where they proceed by timetabled discussions through levels two and three to reach level one again by March. After the Senate and the Council have approved them in March they then flow back down through levels two, three and four. They flow back because built into the process - particularly the budgetary system - is the ability of each area, unit or sub-unit to make further adjustments at their own initiative; indeed incentives to do this are an important part of the overall process.

The planning process is thus a flexible mechanism which can ensure the collective exercise of foresight each year. The process fulfils certain basic functions in common each year (e.g. the formulation of the budget for the next year) but it can also concentrate on particular issues in particular years (e.g. major curriculum redesign in one year, research priorities in another year). The processes are co-ordinated by the Planning Officer in the Vice-Chancellor's Office, and two facts can be stated about this post.

First, the Planning Officer is also responsible for the staff work relating to the organisation of the University; thus the relationship between planning and institutional organisation is reflected in the post and to some extent safeguarded by that fact. Secondly, there is no Planning Office or team; the Planning Officer has to work with and obtain support from the administrators in the field (e.g. the Secretary of Science) and with the administrators in specialist branches (e.g. Data Processing Officer). This situation demonstrates that efficient corporate planning is dependent upon efficient management in all areas of the institution; a centralised planning team cannot over time function with or make up for inefficient line management.

The total range of the planning process cannot be described here in full. However, one of its basic subsidiary functions, budgeting, can be outlined for illustrative purposes. In simplified terms, prior to the introduction of the planning process, budgeting was the responsibility of the Finance and General Purposes Committee of the Council. It was the traditional line budgeting of public administration accountancy, largely built up through bilateral

discussions between the Finance Office and the individual units, and budgetary control was highly centralised. The budgetary system which was introduced in 1968, as part of the planning process, integrates budgeting with forward planning and places accountancy in a wider perspective. In essence, the new process allows the University to allocate money to areas for them to meet the targets and standards set by the plans, and then gives flexibility and incentives to areas and units as the main approach to efficient use of the money. It is an experiment in controlled devolution. The grid (Annex G) outlines the spending activities and units of the University.
The critical part of the budgetary process is the design of the annual budgetary assumptions which form part of the planning assumptions. At the time of their preparation, the next year's income and the requests from the units are largely known from their operational plans; adjustments take place during the budgetary process but the supply and demand for income is known with sufficient accuracy for the budgetary assumptions to be a firm basis for discussion. There are two steps in the preparation of the budgetary assumptions. The first step is the allocation of the expected income to the spending activities in the light of requests and all other relevant information. The calculations are largely done in terms of ratios, with most ratios having average cost assumptions attached to them, e.g. the academic salaries programme allocation will be calculated from a manpower budget of one faculty member per ten students. Ratios are used in preference to ad hoc annual decisions because they provide a continuing framework of reference, allow for the projection of existing commitments, reflect the links which exist between items of expenditure, simplify the issues and therefore concentrate discussion on matters of policy. However, it is important to realise that ratios need to be altered from year to year since the activities and the priorities they represent change and since the resources available change. It is also important to appreciate that although ratios are used in the construction of the budget and represent guidelines on expenditure, the spending units have considerable freedom to depart from these guidelines so long as they are prepared to finance additional expenditure by making off-setting savings. The second step in the drafting of the budgetary assumptions is the dispersal of spending activities amongst the main spending units. In many cases a spending programme belongs exclusively to one spending unit

(e.g. health services and University Health Service) but in other cases the activity has to be divided amongst units (e.g. the academic salaries budget has to be divided into Arts and Science). The attached chart (Annex G) illustrates the grid formed by the relationships between spending units and spending activities. In most cases the allocation of a spending programme's monies to the relevant units will be determined by the ratios referred to above. The result is a single sum for each main spending unit, but with clear indications as to how it is made up. Thus, for Arts and Social Studies £x would be provisionally allocated on the assumption of y students of z "mix", combining £a for faculty, £b for secretarial services, £c for equipment, £g for technical staff, £h for examinations, £i for telephones, £j for portering, £k for cleaning, etc.

The annual cycle of the budgetary process is then also identical to that of the planning process and is illustrated in an attached chart (Annex H). The budgetary assumptions are first submitted to the Planning Committee and the Senate for general comment. The four main areas (Arts, Science, Social Policy and General) are then considered by the senior officers responsible for those areas, and it is at this stage that their assumptions or comments concerning the allocations to sub-units are added. For example, the basic budgetary assumptions contain an allocation to the Science area, but before they are passed to the Science sub-units (schools, subjects) it is necessary to indicate the provisional allocation to those sub-units. Thus, the Chairman of Science and the Science Office analyse the Science funds and provisionally allocate them indicating the basis on which they have made the allocations. The main units have considerable flexibility open to them. They decide the extent to which the various spending activities under their control are divided between sub-units - e.g. Science may decide to "charge-out" technicians and electricity to schools, but Arts may decide not to do so. They also decide the method by which particular spending activities are allocated between sub-units, e.g. although the University allocates technicians on the basis of 1.25 to each logistic member of faculty in Science laboratory subjects, Science is not bound to use this basis in allocating the resultant number of technicians between schools. The budgetary assumptions and main unit comments are then scrutinised and commented upon. Clearly it is open to units to

suggest that they should be given more money than they have been provisionally allocated; but main units are also specifically asked to decide, on the assumption that they will eventually receive only the provisional sums contained in the budgetary estimates, whether they intend to alter significantly the balance of spending programmes. It is at this stage that the units have a major opportunity to exercise control over the distribution of expenditure.

At the end of the decision flow, the Planning Committee, the Senate and the Council make the final allocations to the main units. Those allocations are block sums and thus the main units then allocate funds to their sub-units to fulfil the agreed range of activities. In making those allocations the main units have a further opportunity to exercise initiative since, within certain restrictions, they do not necessarily have to follow the guidelines set by the Planning Committee.

Reference has been made above to the use of ratios in planning and budgeting. The Chart in Annex H illustrates the network of logistic ratios used for the Science Area. Only one of the ratios shown on the Chart is externally imposed (i.e. the ratio of senior to other faculty), the remainder have been developed internal to the University. The first ratio to be established was the one relating staff and student numbers in 1961, and faculty numbers have remained tied solely to student numbers since that time; year by year other derivative ratios were added to that primary one. They provide the main bases for the calculation of the planning and budgetary assumptions, i.e. a logical and easily understandable framework within which discussion can take place. Since student numbers are the main currency of planning and resource allocation, the way in which they are planned needs to be mentioned.

First, the Planning Committee approves projections of student numbers (by total, categories, and areas) for five years ahead on a rolling basis, as part of the planning process. The numbers contained in the projections are termed the logistic student numbers: they are the numbers upon which all resource allocation decisions are based (e.g. faculty numbers, school funds, allocation of space). They represent minimum rather than fixed targets since, within certain limitations, the Arts and Science areas can accept higher

numbers of students provided that extra resources are not thereby requested from the University.

Secondly, the use of the projections for resource allocation purposes varies according to the time perspective of the projections. Projections for the full five years do not represent fixed plans, they are reviewed each year and they are simply the best estimates available of future logistic numbers and their distribution. As such they are used as the main base of the projections of resource allocation (e.g. budgets, faculty logistics, etc.) embodied in the University's operational and strategic plans. However, once the annual process of review has been completed, in March of each year, then elements of the projections become fixed plans until the next annual review and other elements become alterable only at the margin.

The question as to how and when the actual number of students affects the projections and resource allocation needs explanation. It has already been stated above that overshooting ratio and logistic student numbers by units has no effect upon the use of the projections as the base for resource allocation. However, the underachievement of logistic numbers is a different matter; it is taken into account through a procedure which allows marginal underachievement without any corrective action (two-five per cent dependent upon category), which spreads any necessary alterations over a period of time sufficiently long for the unit to make the necessary resource adjustments but which takes away resources from an area if it fails to meet its targets by a significant amount.

The University of Sussex has so far concentrated on the creation and maintenance of an atmosphere conducive to change, on the development of a framework within which participative discussion can take place without stifling action, and on the integration of specialisms and areas into one management structure. The aim is now to build upon those bases through the use of advanced techniques and subsystems; for example, programme budgeting, a management information system and a computerised model of the University are all in the early stages of development in the institution.

The aim of this chapter has not been to describe the full workings of the planning processes and management systems of the University of Sussex, but to present a sufficient outline of them to indicate the way in which one university is attempting to implement a

comprehensive approach towards more systematic planning and management. All that needs to be underlined is that the University of Sussex has no research team working on the problem of management; whatever it has done has emerged from the work and ideas of generalist administrators being approved by faculty committees.

The fact that the University of Sussex is a new institution has obviously helped it to develop new and flexible approaches to management. However, that fact should not mislead older institutions into the belief that such approaches can only be implemented in a new institution. The Ohio State University planning processes(1), for example, are not dissimilar to those of the University of Sussex. The former are more analytically based and differ in detail, but the approach and the concepts in both universities are largely common ones.

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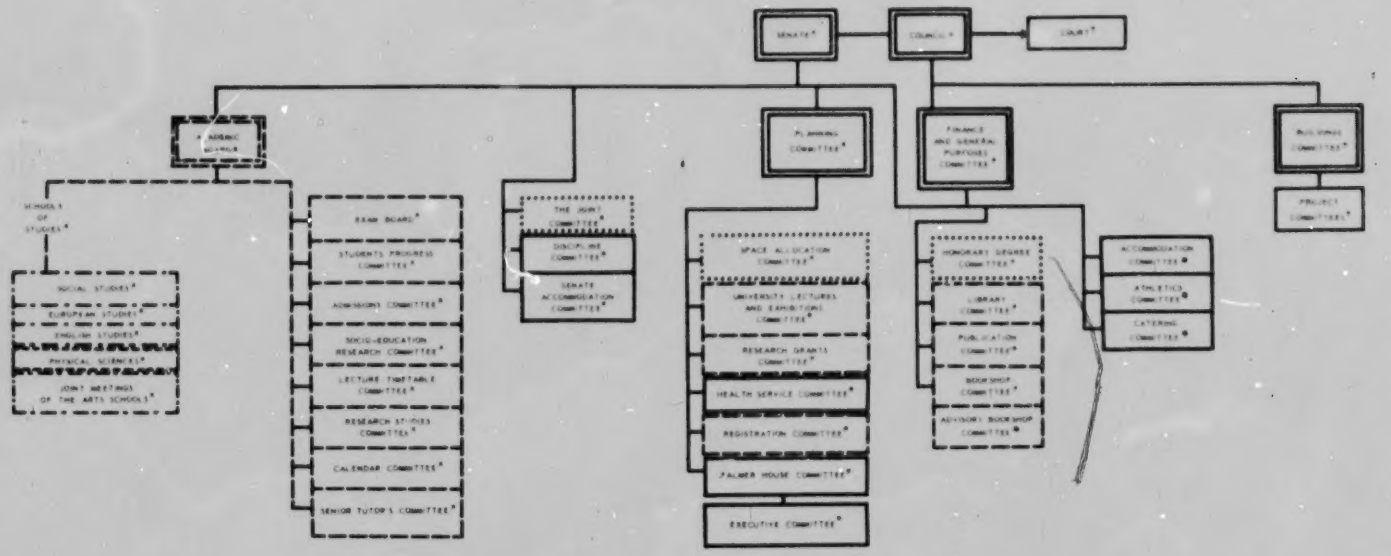
1) University Program Budgeting and University Management Information and Control System, booklets available from the Office of Administrative Research, Ohio State University.

THE UNIVERSITY OF SUSSEX
OUTLINE OF THE COMMITTEE STRUCTURE 1963-64



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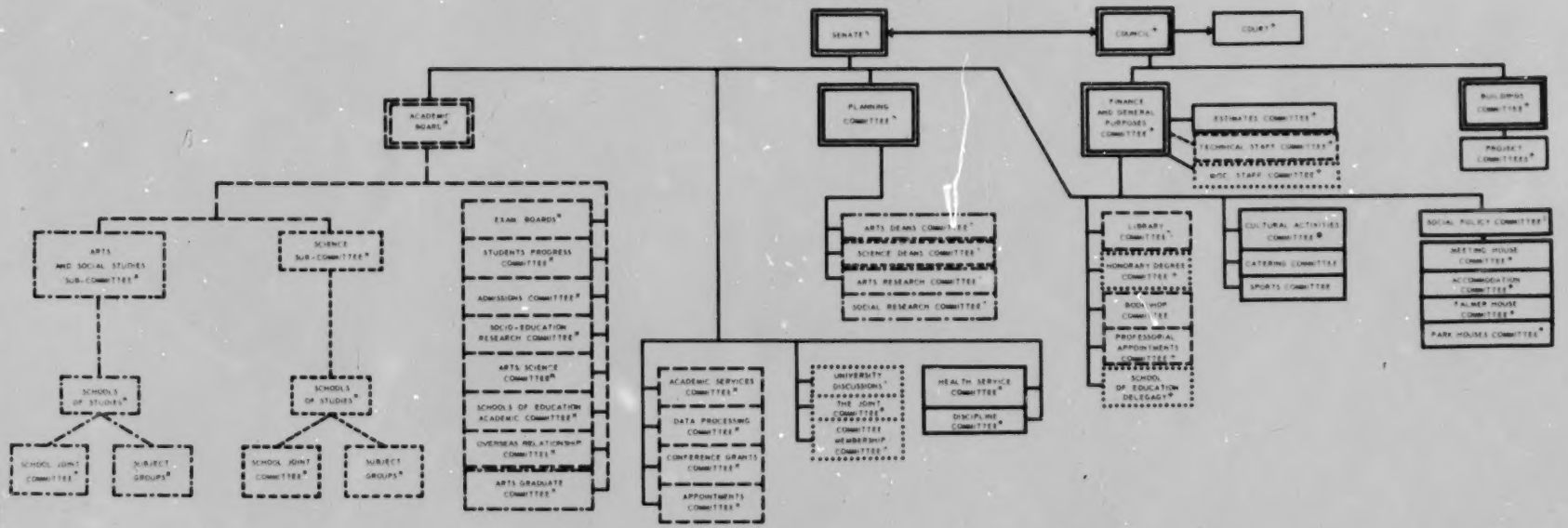
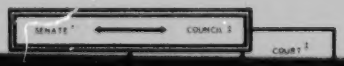
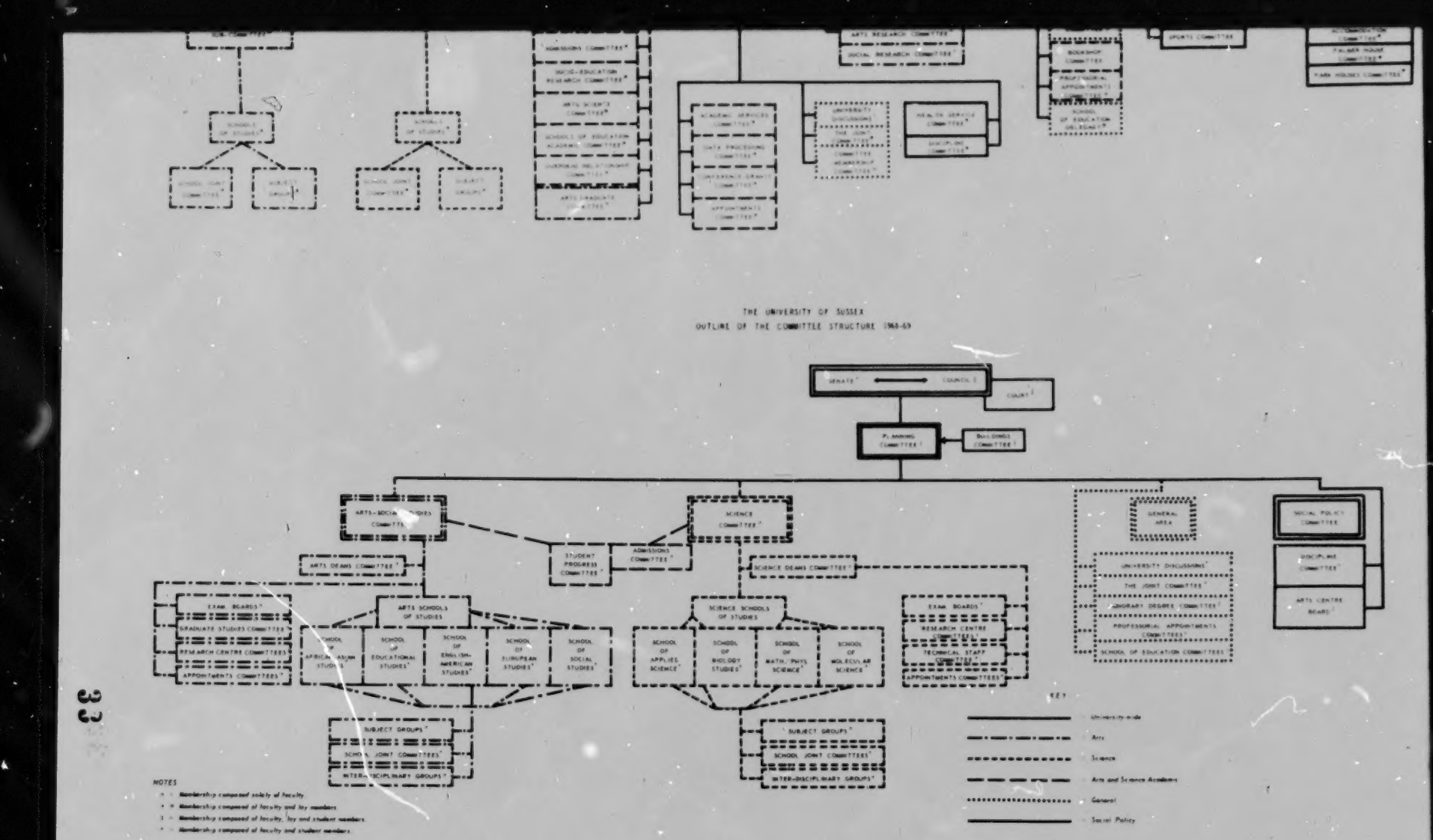
THE UNIVERSITY OF SUSSEX
OUTLINE OF THE COMMITTEE STRUCTURE 1967-68



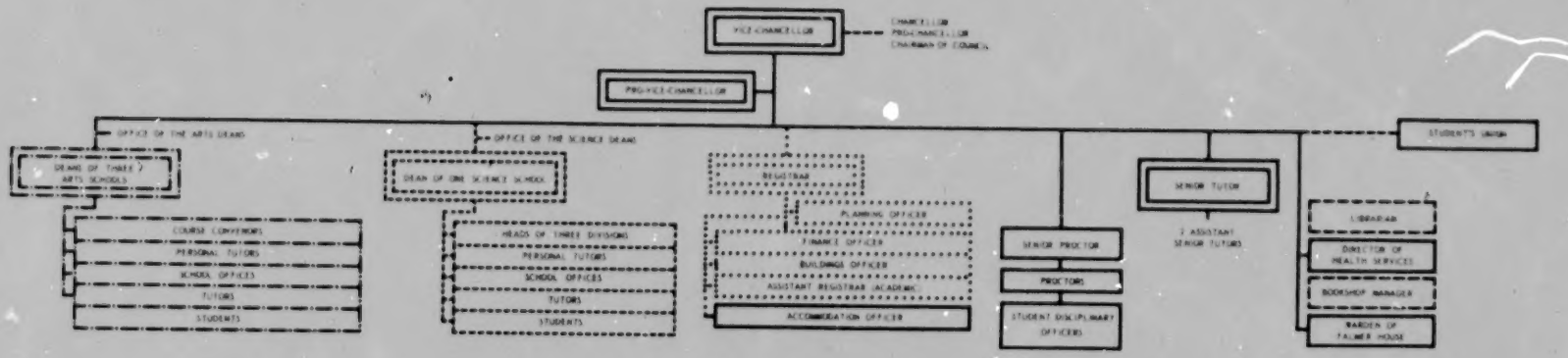
THE UNIVERSITY OF SUSSEX
OUTLINE OF THE COMMITTEE STRUCTURE 1968-69




THE UNIVERSITY OF SUSSEX
OUTLINE OF THE COMMITTEE STRUCTURE 1968-69
SENATE
COUNCIL
COURT
PLANNING
BUILDINGS
ARTS-SOCIAL STUDIES
SCIENCE
GENERAL AREA
SOCIAL POLICY
DISCIPLINE
ARTS CENTRE BOARD
ARTS DEANS
STUDENT PROGRESS
ADMISSIONS
SCIENCE DEANS
UNIVERSITY DISCUSSIONS
THE JOINT
UNDERGRADUATE DEGREE
PROFESSORIAL APPOINTMENTS
SCHOOL OF EDUCATION
EXAM BOARDS
GRADUATE STUDIES
RESEARCH CENTRE
APPOINTMENTS
ARTS SCHOOLS OF STUDIES
SCHOOL OF AFRICAN-ASIAN STUDIES
SCHOOL OF EDUCATIONAL STUDIES
SCHOOL OF ENGLISH-AMERICAN STUDIES
SCHOOL OF EUROPEAN STUDIES
SCHOOL OF SOCIAL STUDIES
SCIENCE SCHOOLS OF STUDIES
SCHOOL OF APPLIED SCIENCE
SCHOOL OF BIOLOGY STUDIES
SCHOOL OF MATH./PHYS. SCIENCE
SCHOOL OF MOLECULAR SCIENCE
RESEARCH CENTRE
TECHNICAL STAFF
SUBJECT GROUPS
SCHOOL JOINT
INTER-DISCIPLINARY GROUPS
KEY
University-wide
Arts
Science
Arts and Science Academic
General
Social Policy
NOTES
* = Membership composed solely of faculty
* = Membership composed of faculty and lay members
* = Membership composed of faculty, lay and student members
* = Membership composed of faculty and student members

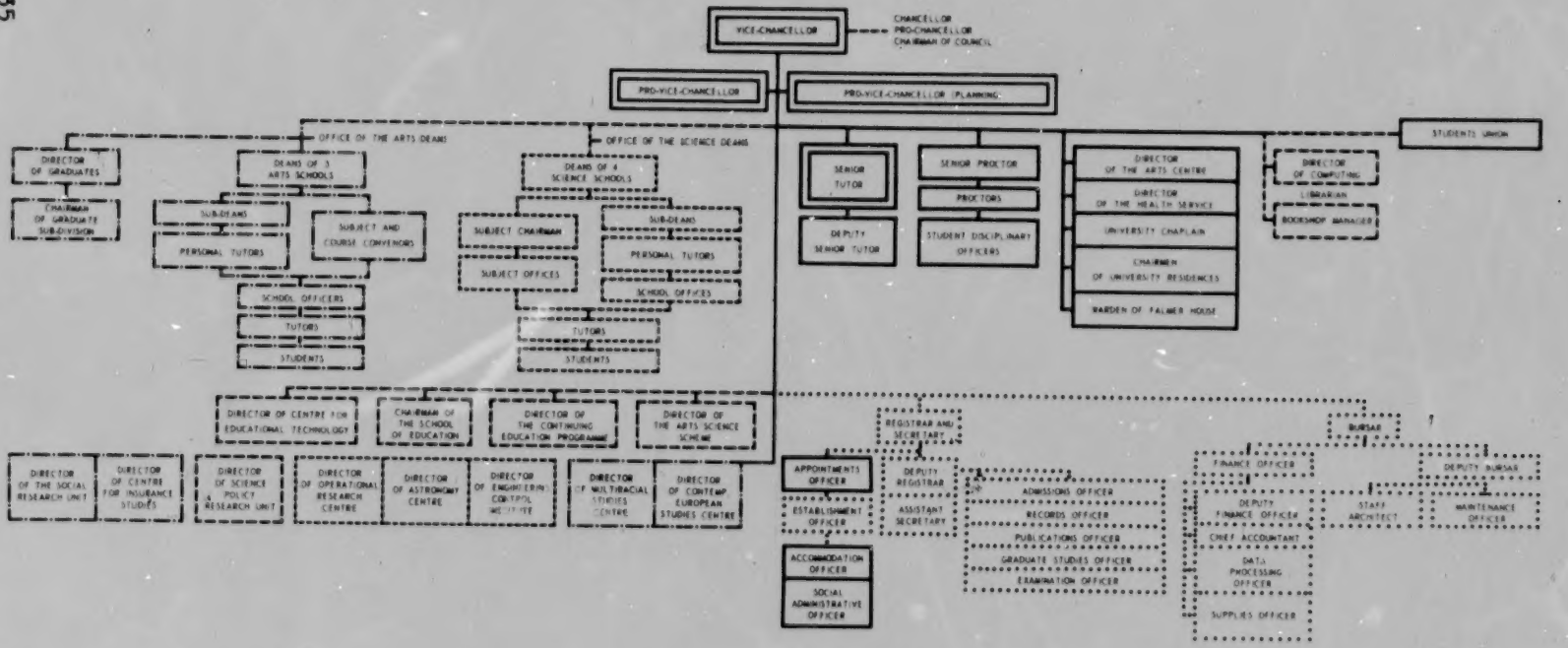
THE UNIVERSITY OF SUSSEX

OUTLINE OF THE MANAGEMENT STRUCTURE 1963-1964



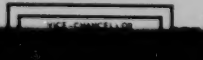
THE UNIVERSITY OF SUSSEX

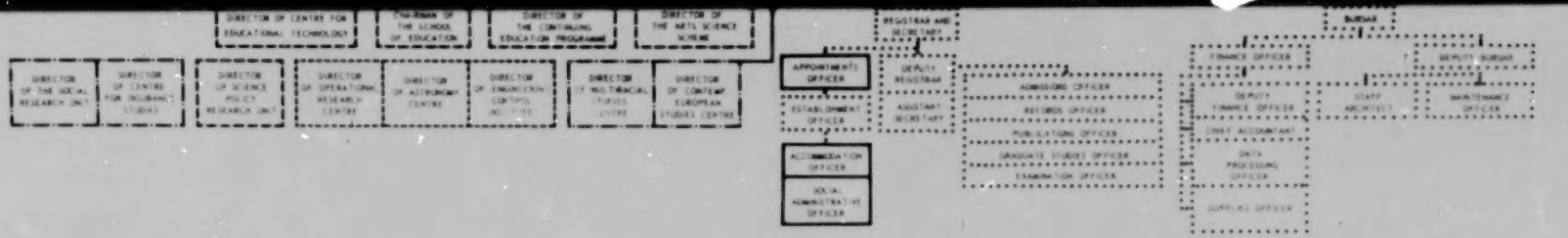
OUTLINE OF THE MANAGEMENT STRUCTURE 1967-1968



THE UNIVERSITY OF SUSSEX

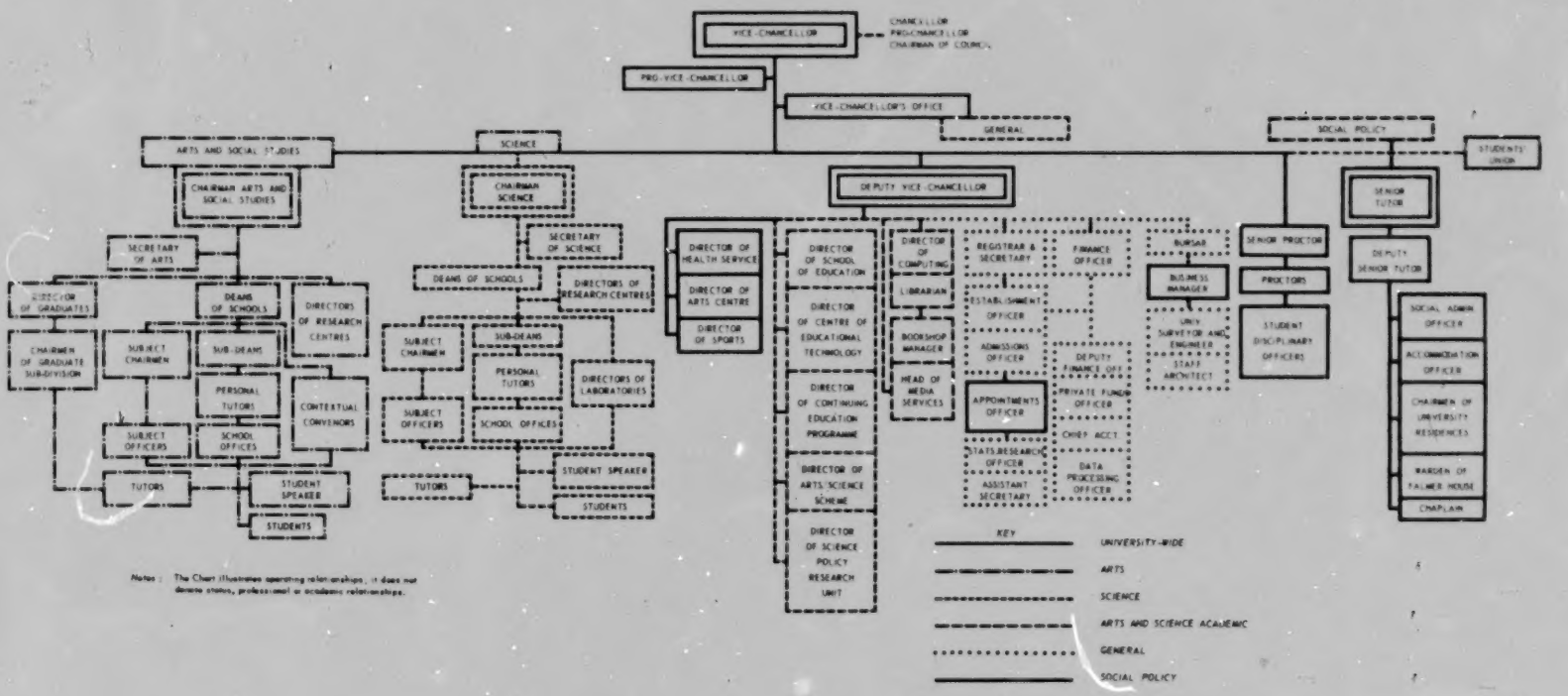
OUTLINE OF THE MANAGEMENT STRUCTURE 1968-1969





THE UNIVERSITY OF SUSSEX

OUTLINE OF THE MANAGEMENT STRUCTURE 1980/81



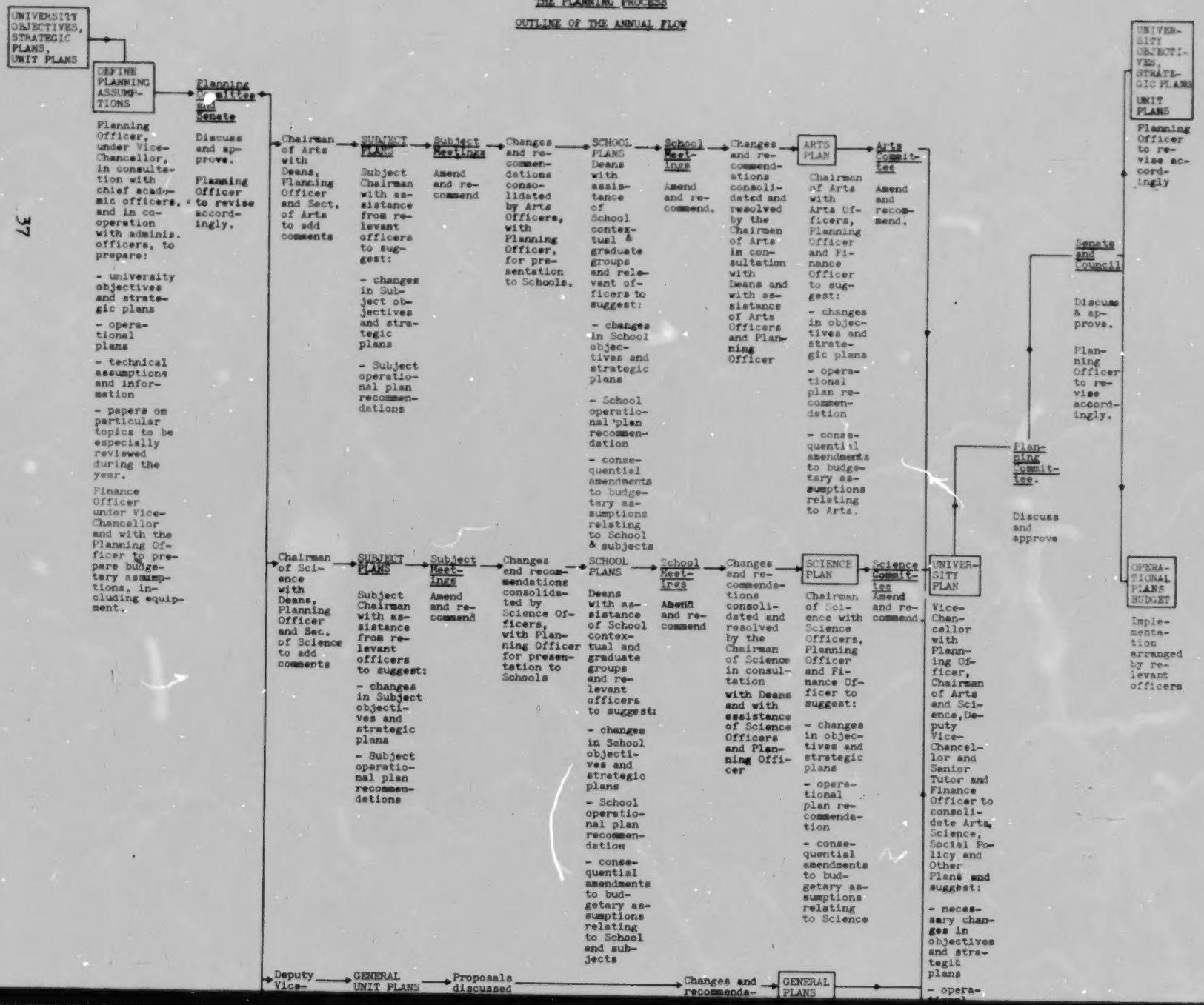
Note: The Chart illustrates operating relationships, it does not denote status, professional or academic relationships.

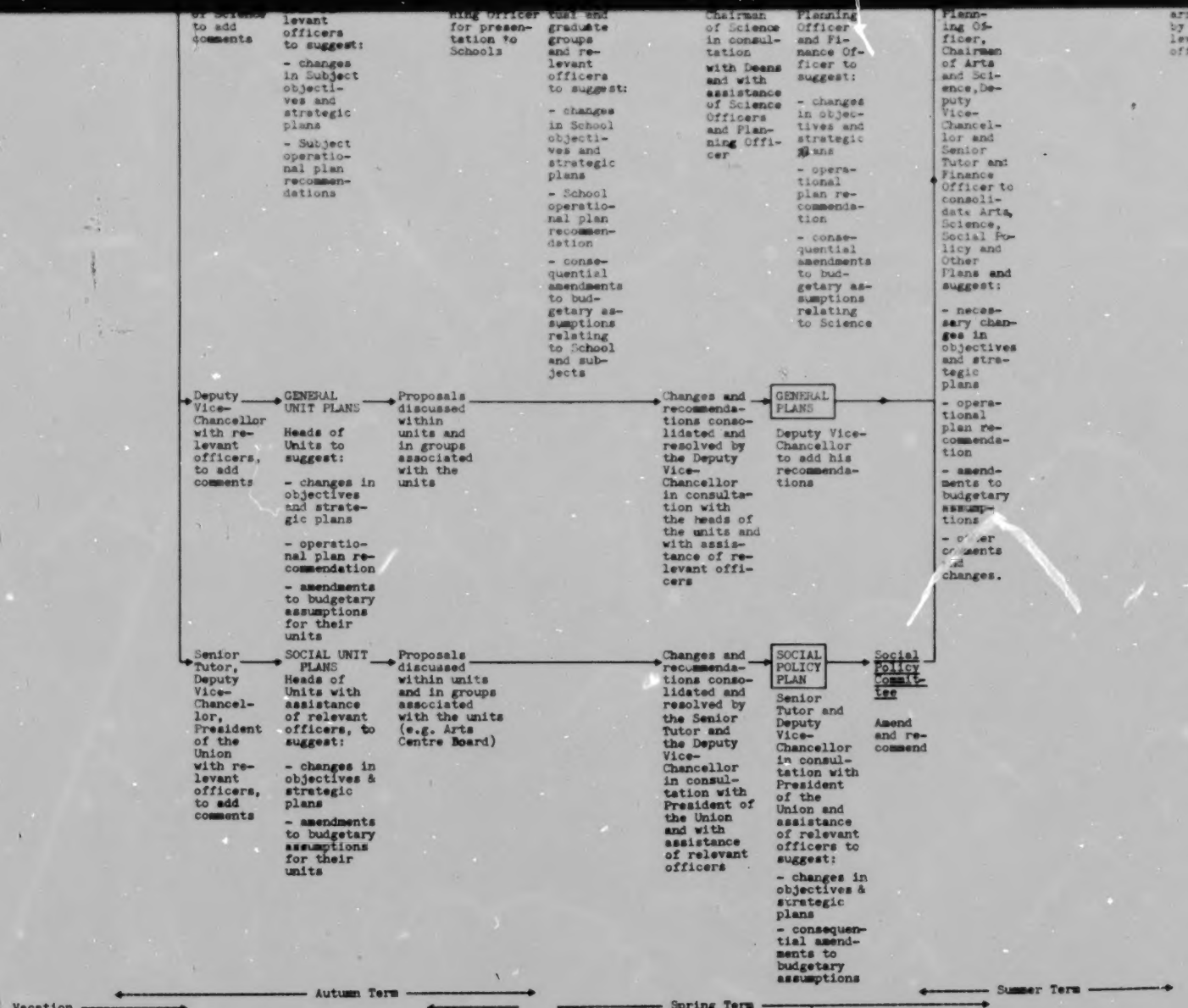
ANNEX C

THE UNIVERSITY OF SUSSEX

THE PLANNING PROCESS

OUTLINE OF THE ANNUAL FLOW


UNIVERSITY OBJECTIVES, STRATEGIC PLANS, UNIT PLANS
DEFINE PLANNING ASSUMPTIONS
Planning Officer, under Vice-Chancellor, in consultation with chief academic officers, and in co-operation with adminis. officers, to prepare:
- university objectives and strategic plans
- operational plans
- technical assumptions and information
- papers on particular topics to be especially reviewed during the year.
Finance Officer under Vice-Chancellor and with the Planning Officer to prepare budgetary assumptions, including equipment.
Planning Committee and Senate
Discuss and approve.
Planning Officer to revise accordingly.
Chairman of Arts with Deans, Planning Officer and Sect. of Arts to add comments
SUBJECT PLANS
Subject Chairman with assistance from relevant officers to suggest:
- changes in Subject objectives and strategic plans
- Subject operational plan recommendations
Subject Meetings
Amend and recommend
Changes and recommendations consolidated by Arts Officers, with Planning Officer, for presentation to Schools.
SCHOOL PLANS
Deans with assistance of School contextual & graduate groups and relevant officers to suggest:
- changes in School objectives and strategic plans
- School operational plan recommendation
- consequential amendments to budgetary assumptions relating to School & subjects
School Meetings
Amend and recommend.
Changes and recommendations consolidated and resolved by the Chairman of Arts in consultation with Deans and with assistance of Arts Officers and Planning Officer
ARTS PLAN
Chairman of Arts with Arts Officers, Planning Officer and Finance Officer to suggest:
- changes in objectives and strategic plans
- operational plan recommendation
- consequential amendments to budgetary assumptions relating to Arts.
Arts Committee
Amend and recommend.
Chairman of Science with Deans, Planning Officer and Sec. of Science to add comments
SUBJECT PLANS
Subject Chairman with assistance from relevant officers to suggest:
- changes in Subject objectives and strategic plans
- Subject operational plan recommendations
Subject Meetings
Amend and recommend
Changes and recommendations consolidated by Science Officers, with Planning Officer for presentation to Schools
SCHOOL PLANS
Deans with assistance of School contextual and graduate groups and relevant officers to suggest:
- changes in School objectives and strategic plans
- School operational plan recommendation
- consequential amendments to budgetary assumptions relating to School and subjects
School Meetings
Amend and recommend
Changes and recommendations consolidated and resolved by the Chairman of Science in consultation with Deans and with assistance of Science Officers and Planning Officer
SCIENCE PLAN
Chairman of Science with Science Officers, Planning Officer and Finance Officer to suggest:
- changes in objectives and strategic plans
- operational plan recommendation
- consequential amendments to budgetary assumptions relating to Science
Science Committee
Amend and recommend.
Deputy Vice-
GENERAL UNIT PLANS
Proposals discussed
Changes and recommenda-
GENERAL PLANS
UNIVERSITY PLAN
Vice-Chancellor with Planning Officer, Chairman of Arts and Science, Deputy Vice-Chancellor and Senior Tutor and Finance Officer to consolidate Arts, Science, Social Policy and Other Plans and suggest:
- necessary changes in objectives and strategit plans
- opera-
Planning Committee.
Discuss and approve
Senate and Council
Discuss & approve.
Planning Officer to revise accordingly.
UNIVERSITY OBJECTIVES, STRATEGIC PLANS UNIT PLANS
Planning Officer to revise accordingly
OPERATIONAL PLANS BUDGET
Implementation arranged by relevant officers


of Science to add comments
levant officers to suggest:
- changes in Subject objectives and strategic plans
- Subject operational plan recommendations
ning Officer for presentation to Schools
tual and graduate groups and relevant officers to suggest:
- changes in School objectives and strategic plans
- School operational plan recommendation
- consequential amendments to budgetary assumptions relating to School and subjects
Chairman of Science in consultation with Deans and with assistance of Science Officers and Planning Officer
Planning Officer and Finance Officer to suggest:
- changes in objectives and strategic plans
- operational plan recommendation
- consequential amendments to budgetary assumptions relating to Science
Planning Officer, Chairman of Arts and Science, Deputy Vice-Chancellor and Senior Tutor and Finance Officer to consolidate Arts, Science, Social Policy and Other Plans and suggest:
- necessary changes in objectives and strategic plans
- operational plan recommendation
- amendments to budgetary assumptions
- other comments and changes.
arranged by relevant officers
Deputy Vice-Chancellor with relevant officers, to add comments
GENERAL UNIT PLANS
Heads of Units to suggest:
- changes in objectives and strategic plans
- operational plan recommendation
- amendments to budgetary assumptions for their units
Proposals discussed within units and in groups associated with the units
Changes and recommendations consolidated and resolved by the Deputy Vice-Chancellor in consultation with the heads of the units and with assistance of relevant officers
GENERAL PLANS
Deputy Vice-Chancellor to add his recommendations
Senior Tutor, Deputy Vice-Chancellor, President of the Union with relevant officers, to add comments
SOCIAL UNIT PLANS
Heads of Units with assistance of relevant officers, to suggest:
- changes in objectives & strategic plans
- amendments to budgetary assumptions for their units
Proposals discussed within units and in groups associated with the units (e.g. Arts Centre Board)
Changes and recommendations consolidated and resolved by the Senior Tutor and the Deputy Vice-Chancellor in consultation with President of the Union and with assistance of relevant officers
SOCIAL POLICY PLAN
Senior Tutor and Deputy Vice-Chancellor in consultation with President of the Union and assistance of relevant officers to suggest:
- changes in objectives & strategic plans
- consequential amendments to budgetary assumptions
Social Policy Committee
Amend and recommend
Vacation
Autumn Term
Spring Term
Summer Term

ANNEX D

THE UNIVERSITY OF SUSSEX

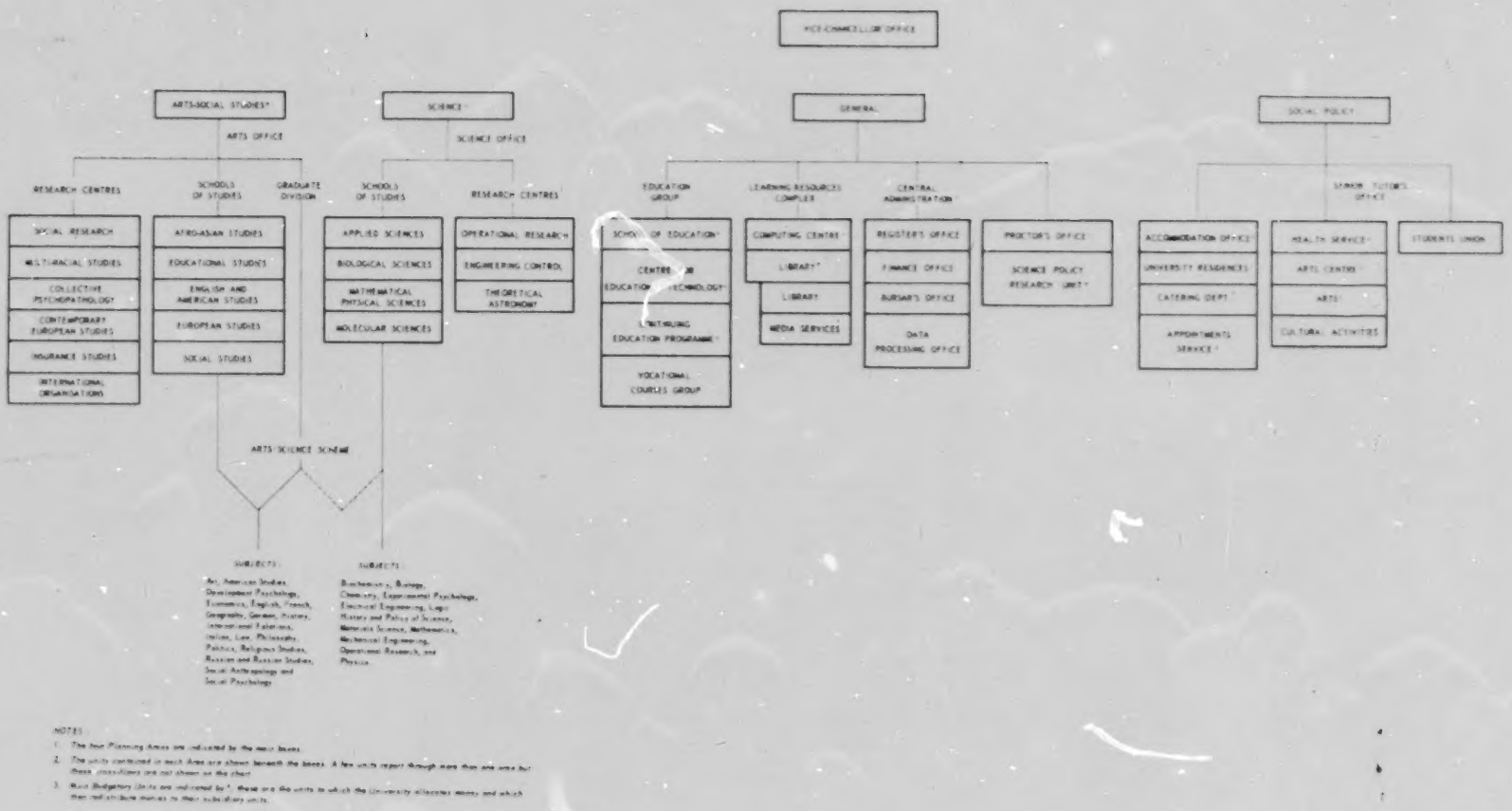
PLANNING PROCESS: AN OUTLINE OF THE CONTENTS

TYPE OF PLAN	STRATEGIC (4-6 year plan)	OPERATIONAL (2-3 year plan)	BUDGET (1-year plan)
CONTENTS	e.g. major academic developments, long-term rate of growth, phased building programme.	e.g. student numbers by courses and subjects, curriculum changes, space allocation.	i.e. allocation of monies for the year for agreed programmes, and consequential matters (e.g. manpower budget, student number targets).
AIDS TO PREPARATION	Statement of financial situation. Planning Guide for Units. Strategic Assumptions (e.g. size of Univ.). Statistics and research findings, national and internal (e.g. Arts/ Science swing).	Statement of monies available in each year. Planning Guide for Units. Operational Guide-lines (e.g. projections of faculty numbers). Statistics on current state of the University (e.g. student numbers, admissions pressure, faculty distribution etc.).	Guidebook of Regulations. Budgetary System Description. Current Year's Accounts. Budgetary Assumptions (i.e. monies available in the year and provisional internal allocations).
PROGRESS CONTROLS	Operational Plans and Budget preparation, progress reports and controls.	Regular reports and statistics (e.g. admissions, current students, space, manpower). Records and Statistics Description. Various progress and control mechanisms to be set up by relevant committees (e.g. Arts and Science Committees for curriculum, teaching methods etc.).	Control Statements to the Planning Committee every term. Finance Office monthly statements to the Vice-Chancellor. Finance Office monthly reports to each main spending unit. Establishments Office progress reports. Admissions Office progress reports.

Annex I

THE UNIVERSITY OF SUSSEX

THE PLANNING PROCESS: PLANNING AREAS AND UNITS



NOTES:

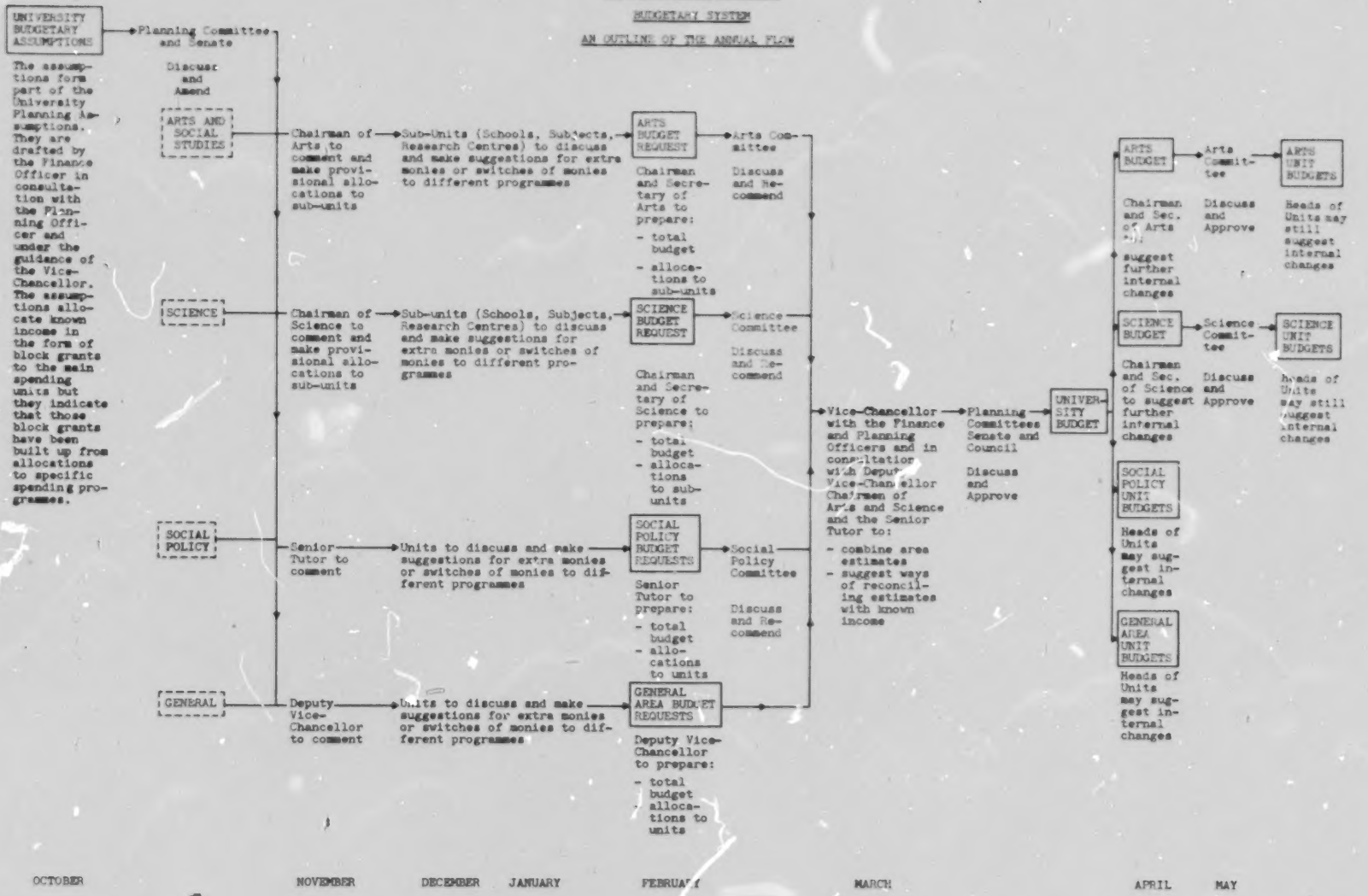
1. The four Planning Areas are indicated by the main boxes.
2. The units contained in each Area are shown beneath the boxes. A few units report through more than one area but these cross-lines are not shown on the chart.
3. Main Budgetary Units are indicated by *, these are the units to which the University allocates money and which then redistribute monies to their subsidiary units.

ANNEX F

THE UNIVERSITY OF SUSSEX

BUDGETARY SYSTEM

AN OUTLINE OF THE ANNUAL FLOW


UNIVERSITY BUDGETARY ASSUMPTIONS
The assumptions form part of the University Planning Assumptions. They are drafted by the Finance Officer in consultation with the Planning Officer and under the guidance of the Vice-Chancellor. The assumptions allocate known income in the form of block grants to the main spending units but they indicate that those block grants have been built up from allocations to specific spending programmes.
Planning Committee and Senate
Discuss and Amend
ARTS AND SOCIAL STUDIES
SCIENCE
SOCIAL POLICY
GENERAL
Chairman of Arts to comment and make provisional allocations to sub-units
Chairman of Science to comment and make provisional allocations to sub-units
Senior Tutor to comment
Deputy Vice-Chancellor to comment
Sub-Units (Schools, Subjects, Research Centres) to discuss and make suggestions for extra monies or switches of monies to different programmes
Sub-units (Schools, Subjects, Research Centres) to discuss and make suggestions for extra monies or switches of monies to different programmes
Units to discuss and make suggestions for extra monies or switches of monies to different programmes
Units to discuss and make suggestions for extra monies or switches of monies to different programmes
ARTS BUDGET REQUEST
Chairman and Secretary of Arts to prepare:
- total budget
- allocations to sub-units
SCIENCE BUDGET REQUEST
Chairman and Secretary of Science to prepare:
- total budget
- allocations to sub-units
SOCIAL POLICY BUDGET REQUESTS
Senior Tutor to prepare:
- total budget
- allocations to units
GENERAL AREA BUDGET REQUESTS
Deputy Vice-Chancellor to prepare:
- total budget
- allocations to units
Arts Committee
Discuss and Recommend
Science Committee
Discuss and Recommend
Social Policy Committee
Discuss and Recommend
Vice-Chancellor with the Finance and Planning Officers and in consultation with Deputy Vice-Chancellor Chairmen of Arts and Science and the Senior Tutor to:
- combine area estimates
- suggest ways of reconciling estimates with known income
Planning Committees Senate and Council
Discuss and Approve
UNIVERSITY BUDGET
ARTS BUDGET
Chairman and Sec. of Arts to suggest further internal changes
Arts Committee
Discuss and Approve
ARTS UNIT BUDGETS
Heads of Units may still suggest internal changes
SCIENCE BUDGET
Chairman and Sec. of Science to suggest further internal changes
Science Committee
Discuss and Approve
SCIENCE UNIT BUDGETS
Heads of Units may still suggest internal changes
SOCIAL POLICY UNIT BUDGETS
Heads of Units may suggest internal changes
GENERAL AREA UNIT BUDGETS
Heads of Units may suggest internal changes
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY

ANNEX C

THE UNIVERSITY OF SUSSEX - THE PLANNING PROCESS

THE BUDGETARY PROCESS - MAIN SPENDING UNITS AND SPENDING PROGRAMMES

SPENDING PROGRAMMES	MAIN SPENDING UNITS: Primary basis of ratios governing provisional allocation of funds	ARTS & SOCIAL STUDIES	SCIENCE	SCHOOL OF EDUCATION	CONTINUING EDUCAT.	LINGUA-T	INT	COMPUTING CENTRE	AUDIO-VISUAL AIDS	THE ADMINISTRATION	CATERING	UNIV. RESIDENCES	INT. CENTRE	HEALTH SERVICE	SPORTS	ACCOM. OFFICE	INT. STUDENTS OFFICE	PROG-TOR'S OFFICE
ACADEMIC FACULTY SALARIES	Student numbers	x*	x*															
TECHNICAL STAFF SALARIES	Student & faculty numbers	x*	x*				x											
GENERAL TEACHING SUP. PROG.	Student & faculty numbers	x	x				x											
GENERAL RESEARCH SUP. PROG.	Student & faculty numbers	x	x															
SECRETARIAL ASSIST. (ACADEM.)	Faculty numbers	x*	x*															
TEACH. RESEARCH & DEVELOPM.	Ad hoc	x	x	x			x											
OFFICE EXPENSES (ACADEMIC)	Faculty numbers	x	x															
EQUIPMENT	Student numbers	x*	x*	x*	x*	x*	x*	x*		x*			x*	x*	x*			
EXAMINATIONS	Student numbers	x*	x*	x*														
RECORDS AND STATISTICS	Student numbers	x*	x*	x*						x								
EXCHANGE PROGRAMMES	Ad hoc	x*	x*															
TRAVEL AND CONFERENCE GRANTS	Faculty numbers	x	x	x	x	x	x	x										
GRANTS TO LEARNED SOCIETIES	Faculty numbers	x	x															
MERIT AND HARDSHIP GRANTS	Student numbers	x	x							x*								
RECRUITMENT AND PERSONNEL	Staff numbers	x*	x*	x*	x*	x*	x*	x*	x*	x*		x*	x*	x*	x*	x*		
HOSPITALITY	Faculty numbers	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
LIBRARY RUNNING COSTS	Student numbers			x*		x												
LIBRARY BOOKS, BINDING, etc.	Student Numbers			x*		x												
COMPUTER FIXED COSTS	Faculty numbers							x										
COMPUTER MARGINAL COSTS	Faculty numbers	x	x					x		x								
DATA PROCESSING PROGRAMME	Ad hoc	x*	x*			x*				x*								
LEARNED PUBLICATIONS	Faculty numbers	x	x															
INTERNAL PUBLICATIONS	Student & faculty numbers									x*								
EXTERNAL OFFICIAL PUBLICAT.	Ad hoc	x*	x*	x*	x*					x*								
HEALTH SERVICES	Student numbers													x				
CAREERS SERVICES	Student numbers								x									
ACCOMMODATION SERVICES	Student numbers											x				x		
SPORTS SERVICES	Student numbers														x			
CATERING SERVICES	Self-financ. or fixed subsidy										x							
ADMISSIONS SERVICE	Student numbers	x*	x*							x*								
SOCIAL RESEARCH UNIT	Faculty numbers	x																
CEREMONIALS	Ad hoc	x*	x*							x								
TELEPHONES	Staff numbers	x*	x*	x*	x*	x*	x*	x*	x*	x*		x*	x*	x*	x*	x*	x*	x*
CLEANING	Size of plant	x*	x*	x*	x*	x*	x*	x*	x*	x*		x*	x*	x*	x*	x*	x*	x*
PORTERING	Size of plant	x*	x*	x*	x*	x*	x*	x*	x*	x*		x*	x*	x*	x*	x*		
TRANSPORT	Ad hoc	x*	x*	x*	x*	x*				x*			x*		x*			
FUEL, LIGHT, WATER & POWER	Size of plant	x*	x*	x*	x*	x*	x*	x*	x*	x*		x*	x*	x*	x*	x*	x*	x*
INTERNAL MAIL SERVICE	Size of plant	x*	x*			x*				x								
SUB POST OFFICE	Ad hoc									x								
POST-ENTRY TRAINING	Staff numbers	x*	x*			x*				x								
UNIV. CONTRIB. TO OFF. BODIES	Ad hoc									x								
PUBLIC LECTURES	Ad hoc	x	x															
SOCIO-ECON. RESEARCH PROGRAM.	Ad hoc									x								
CULTURAL ACTIVITIES	Student numbers												x				x	
IN-SERVICE TRAIN. OF TEACHERS	Ad hoc			x														
COLLEGES OF EDUCAT. SUPPORT	Ad hoc			x														
ADULT EDUCATION	Ad hoc				x													
GENERAL GROUNDSMAINTENANCE	Size of plant									x					x			
GENERAL BUILD. MAINTENANCE	Size of plant									x†								
BUILDINGS MINOR ALTERATIONS	Size of plant	x*	x*			x*				x*		x*	x*		x*			
BUILDINGS MAJOR ALTERATIONS	Size of plant	x*	x*			x*				x*		x*	x*		x*			
BUILDINGS RE-DECORATION	Size of plant									x*								
FURNITURE	Size of plant	x†	x†			x†				x*								
RENTS	Ad hoc									x								
INSURANCES	Ad hoc									x								
LEGAL AND AUDIT EXPENSES	Ad hoc									x								
GENERAL ADMINISTN. SALARIES	Student numbers									x†							x†	
DISCIPLINE	Student numbers																	x*
RESERVE FUND	Ad hoc									x								

NOTES: 1. This grid has been produced for ILLUSTRATIVE PURPOSES; its contents have not yet been fully implemented in the existing Budgetary Process.

2. The spending programmes differ from the existing budget heads. The Guide to Regulations will contain a detailed statement on each programme, e.g. Teaching Support Programme includes teaching materials and other aids, running costs of the Language Laboratory; Research Support Programme includes grants to individuals for research projects, etc.; Office Expenses include stationery, postages, copying costs, etc.; Academic Salaries Programme includes all payments for the teaching of internal students (e.g. Arts/Science posts, Tutorial Fund, demonstrating payments, payments to College of Education for Cert. Ed. students, etc.); Merit and Hardship Grants include the Vice-Chancellor's Fund, Overseas Student Bursaries, etc.; Recruitment and Personnel includes all advertising, interview expenses, removal expenses, etc.; Hospitality includes catering expenditure on internal meetings; Internal Publications include the Telephone Directory, the Faculty Handbook, the Bulletin, the Diary of Events, etc.

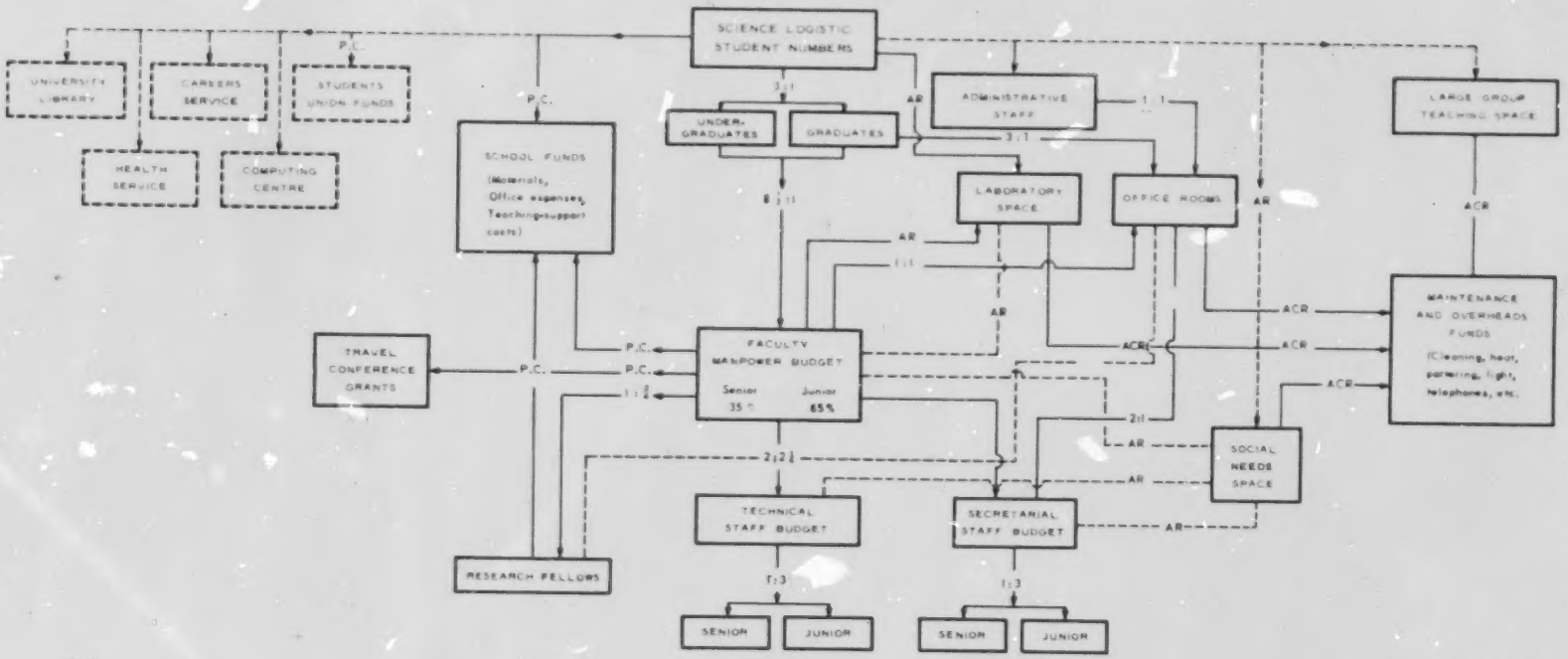
3. A cross indicates that the Budgetary Assumptions for that main spending unit will include an amount for that programme. An asterisk indicates that for that programme the unit exercises its main control at the budget construction stage and has less or no control at the spending stage. A dagger indicates that savings arising during the year on that programme revert partly or wholly to the University Reserve Fund and are therefore not fully available for use on other programmes within that unit.

4. Self-financing programmes (e.g. Conferences, Printing) are not included.

Annex H

THE UNIVERSITY OF SUSSEX - PLANNING AND BUDGETING

A diagram illustrating the inter-related ratios used for planning and budgetary purposes.
The diagram represents those ratios in the Science Area.



NOTES

1. ——— Ratios already in use.
2. - - - - - Ratios under consideration.
3. P.C. : Per capita sums; the sums are fixed but they vary according to the Subject or the Year of Study.
4. AR : Area ratios per head; the ratios are fixed but they vary according to the nature of the appointment.
5. ACR : Area cost ratios; the ratios are fixed (e.g. fix per square foot for cleaning) but vary according to the item.
6. 1:2 etc. : Direct Manpower ratios (using fixed average salaries).
7. ▭ Budgets within the Science Area.
8. ▭ Budgets outside the Science Area.

CHAPTER 3

THE INFORMATION SYSTEMS FOR UNIVERSITIES

This chapter is concerned with management information narrowly defined as the information required for decision-making purposes and broadly defined to include integrated consultancy as well as information standardisation for a number of universities. We shall illustrate the work carried out at Yale University in building a sophisticated information system for internal management, and also describe the German experience in setting up integrated inter-university information systems.

In 1963, Yale University began such a study of its requirements, including special seminars at which senior managers discussed the matter with external computing experts. By 1964, it had decided to establish an Administrative Data Systems department, responsible jointly to the Provost and the Treasurer for developing a computer-based information system designed to provide information at the point and time of need. The following summary of the ensuing developments is based upon a paper written for OECD by Dr. Carl Roessler, head of the Administration Data Systems department. The first study of the new department indicated that existing data systems were too illogical and insufficiently precise to be used as a basis for the new system; thus the conclusion was that a new basic structure for Yale data would have to be designed. Depending upon local circumstance, universities have tended to make a start on information systems in the student record and admissions area, the accounting area, or the space allocation and utilisation area; these bases were then extended with the object of gradually covering all the data areas. At Yale, first priority was given to the accounting system. The restructuring of the accounting system was to enable requests for

information on current financial matters to be answered quickly and reliably, to provide a sound historical file for retrospective studies and searches, and to enable future projections to be made with a full understanding of present and past data and trends. The key to the re-designed accounting system is a basic numeric structure in which each item has a fifteen-digit code composed of four elements:

1) A four-digit Budgetary Unit number identifies a budgetary activity. This activity may be a building, a department, or a special function. These numbers are arranged in logical groupings so that similar departments, such as instructional or administrative departments, are grouped within a range of numbers.

2) A two-digit School number identifies the major organisational components within which the Budgetary Units operate.

3) A five-digit Source of Funds number identifies an individual "pocket-book" - an endowment fund, a federal grant or contract, a building fund, or any other individual monies to be accounted for separately. These individual funds may be active within any of the previously mentioned Budgetary Units and Schools.

4) A four-digit Type Code identifies the specific type of asset, liability, income or expense. The first two digits of this number indicate a major type (for example, salaries) and the second two digits indicate sub-type (faculty salaries or supporting salaries).

The large number of combinations and permutations of these numbers enables a great variety of individual separations and aggregations of financial data. In addition, because each number is functionally unique, the computer can attach a verbal description as an aid in interpreting the information reported by number.

The computer used is an IBM 360 Model 40, which has a television display output controlled through an attached keyboard by which users can interrogate the computer about the 250 million characters of data held in the system. There are twenty television terminals in different administration offices. Three users can question the system simultaneously and the computer produces a monthly list of the officers who have used the system in that month. The list of interrogations runs into thousands each month, which is evidence of the system's usefulness. No charges are yet made for usage, and the

most frequent users are the senior managers who assist the chief officers of the University. The system handles the problems of access by keeping within the system a statement of the files which each manager has a right to scrutinise. Each manager has an identification key which he has to give to the system, and the computer then checks his profile before allowing access to any data within the system. If a manager requests the system to provide him with data from a file which his profile does not cover, the system informs him of the person from whom he needs authority before that data can be shown to him.

The new accounting system produced during 1965 fulfilled the aims mentioned above and also produced additional benefits. For example, the new system demonstrated that a large number of accounting transactions are of a secondary nature and it was possible in the programming to have the computer programmes logically produce many of these secondary transactions. These computer-produced transactions account for approximately thirty per cent of the total transaction volume in the system, thus saving a great deal of clerical work. On completion of the accounting systems, the Administrative Data Systems department began the extensions of the information system towards budgeting, admissions, student and alumni records, and the personnel and payroll files. At that time, in 1965, Yale could find no complete systems in operation elsewhere from which it could learn; the institution therefore produced its own assumptions and used its own staff to design the system and write the programmes. The main assumptions can be summarised under three headings. First, the system should support the senior management; it should be an essential aid for the twenty or so senior managers who make a substantial proportion of the institution's decisions rather than being merely a technological replacement or support for clerical staff. Secondly, the system had to allow managers, who were not programmers and who may not have detailed knowledge of the structure of the data, to use it with a minimum of frustration. Thirdly, the technicalities of the system should allow multi-functions to be performed simultaneously (i.e. a time-sharing computer) and permit several interrogations to take place at any one time without disrupting the large production jobs; they should also include terminals in the offices of the managers and enable selected information to be presented quickly and clearly to the managers (e.g. television displays).

At present, the work of extending the system into the areas of student and alumni records is continuing, and thought is now being given to the use of the information system for integrated planning purposes. Thus, Yale provides an example of a university which has approached the problems of institutional planning by developing an integrated information system before attempting to use advanced mathematical models. This approach argues that models cannot be efficiently designed or effectively implemented within a particular institution unless the latter has already tackled the problem of systematising its information collection, storage, flow and analysis. Only when this has been done can an understanding of the real functioning of the institution be obtained and used in the building of behavioural models.

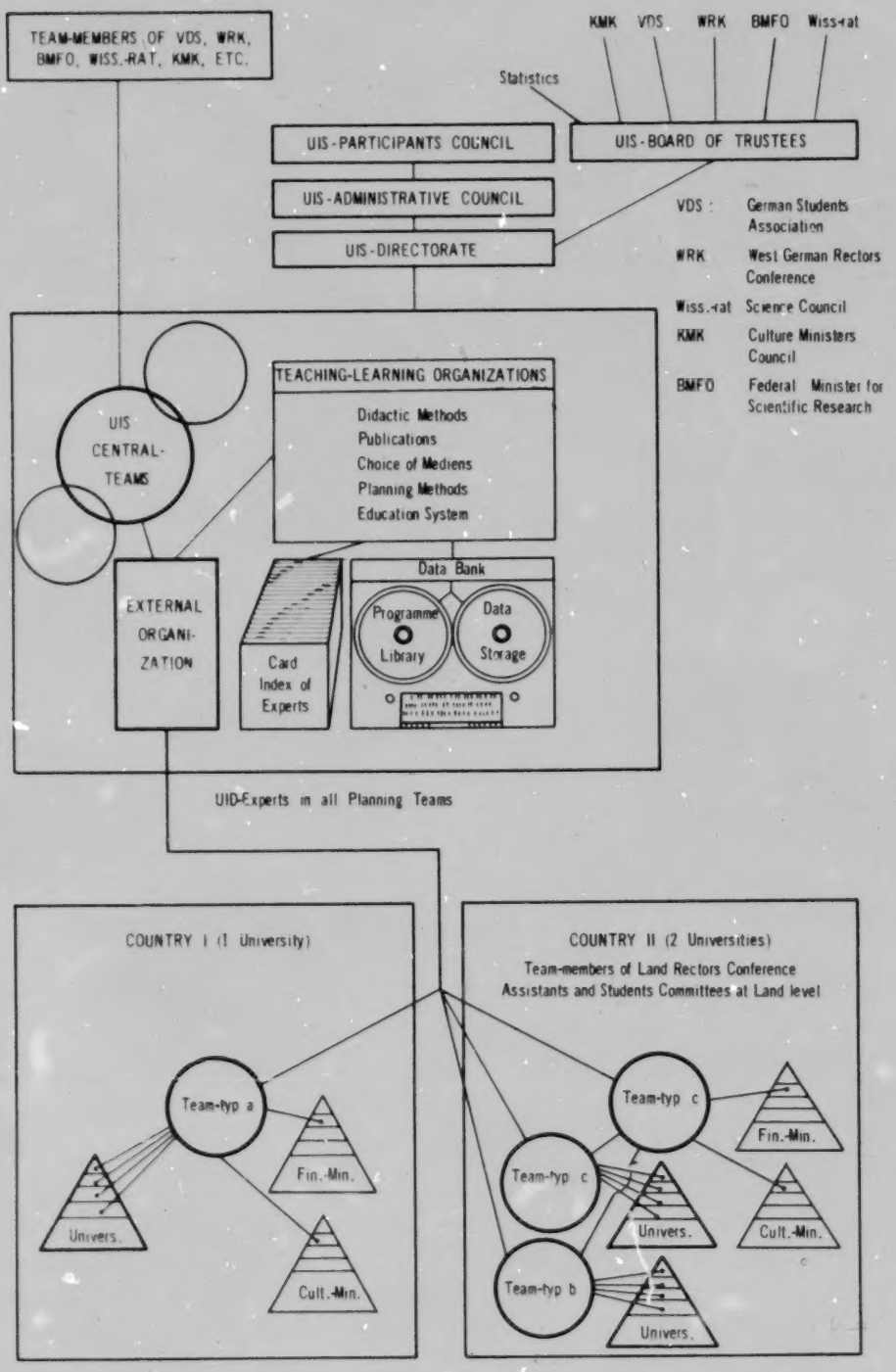
Some general points emerge from the experience at Yale in the design and implementation of an information system. First, the work increases organisational stress by, for example, criticising the performance of current managers and raising questions concerning the right of access to information. Secondly, it is absolutely imperative for the senior management to be information-oriented before the institution undertakes developments in this field. Information systems are an aid to knowledgeable managers who are interested in change; they are not a crutch for the ignorant and inefficient. The main obstacle to the development of information systems and planning models is the difficulty of getting very busy chief officers deeply involved and highly committed to the systems approach. Thirdly, the development of such systems is expensive and time-consuming. The Yale system uses one third of the time of a computer and employs approximately twelve members of staff. The developments so far at Yale have taken over five years and the system does not yet cover the entire range of data: its coverage of student data is not complete and files on space, equipment, etc., are not yet designed. Unfortunately for other institutions, no cost-effectiveness information is available on the Yale experiment. Fourthly, the five years of experience do not seem to have produced any significant innovations outside or beyond the information system itself; the planning function, for example, still appears to be diffuse and segmented in spite of the integration of its data base. The experience must therefore lead to caution in the immense claims often made for information

systems, and also emphasizes that, for maximum effect, information systems should be designed and implemented as sub-systems within a total management system. The experience demonstrates that the technical barriers to the storage and display of information are surmountable and are less obstructive to progress than the structural problems of institutional organisation and the attitudes of senior management.

The new University Information System (UIS) for the Federal Republic of Germany and West Berlin provides an example which moves towards the concept of an integrated consultancy for a number of universities. UIS is a service designed to make available the best methods, experts and knowledge to those responsible for planning and decision-making in individual institutions. Its purpose is to help individual institutions and, in doing so, make the best use of the public monies devoted to higher education. UIS is a non-political organisation in a trust capacity; it is privately financed and it is hoped that its functions will eventually be assumed by the university system itself. UIS will foster a team approach to institutional problems. Where requested it will tackle organisational and planning problems in a university by establishing a planning team consisting of faculty, students and administrators from the institutions and a group of UIS experts. The UIS experts whilst working with such a team will be subordinate to the university authorities. UIS will support such teams with the information, methods and other help necessary for their work. UIS will also create planning teams - at UIS headquarters but drawn from amongst institutional administrators and other staff - to tackle problems common to all institutions. It will also undertake research relevant to individual institutions, for example, into the development of new criteria to judge efficiency effects which are not at this time measurable. The training of university planners and managers will also be assisted by UIS. The development of UIS will be interesting to watch to see whether it can be used as a model in other countries. The Chart is a representation of UIS operations.

UIS is adopting a realistic approach to what is possible in the time available. The following is an extract from the paper on the University Information Service written for OECD by Dr. Waldemar Krönig. "Planning in the university system can be carried out

THE UNIVERSITY INFORMATION SERVICE IN WEST GERMANY



within short-, medium- and long-term time dimensions. The three corresponding strategies are to be as follows:

Strategy	Relation to the target
A. Fixed course	Retaining the present position with slight improvements
B. Determined evolution	Aiming at a fixed target with structural changes
C. Indetermined evolution	Aiming at a changing target

For the execution of these strategies various information and method requirements (software) are established:

Information requirement	Present state of information with regard to information requirement	Methods requirement	Present state of methods with regard to requirement
A. medium	hardly sufficient	medium	good
B. large	inadequate	large	sufficient
C. very large	totally unsatisfactory	very large	insufficient

From this can be concluded:

A. With improvements in the information system which proceeds with an economic rationalisation of universities, the 'retaining strategy' can be optimised (i.e. cost reduction with equal success). The necessary methods are either available or to be developed with certainty.

B. For the 'attaining of a fixed target' in such a complex system as the universities, strongly integrated planning is needed for which the present state of information inquiry is totally inadequate. However, a large part of the necessary methods are developed, or at least can be developed, for application in a foreseeable period of time (i.e. determined improvements in the university system with simultaneous economic optimising; thus the growth rate of success is greater than the growth rate of costs).

C. The 'execution of a changeable target', contrary to B, requires additional information and methods still to be developed (i.e. constant adaptation to changing targets with simultaneous economic optimising brings an even greater growth rate of success than in B, if 'success' is defined in terms of steering for a target which is the constant approach to changing social values).

The educational planning strategies executed at present between A and B are, in fact, probably nearer to A. Discussion of the various reform plans at least has B as the basis and aims with differing intensity at C.

Task setting and organisation of a university information system must be derived from these three strategies. Thus UIS has to work methodically at three levels of diminishing importance:

A. Short-term efficiencies of the existing university system, methodically already possible and effective = close-up target relevant information system (improvements in administration, building planning and investment planning).

B. Medium-term information for target clarification and attainment = distant target relevant information system (university reform measures).

C. Long-term permanent target procedure = target searching information system (readiness for constantly changing education system).

CHAPTER 4

BUDGETARY PLANNING AT THE UNIVERSITY OF CALIFORNIA

Chapter 1 referred to the obvious fact that many of the problems confronting universities are directly financial in nature, and that all of the problems require a more rational approach to the allocation of resources. Universities have disparate objectives and projects, which to be related and compared require a common denominator. Money is the only common denominator available. Thus, the financial management of a university has importance and relevance beyond the traditional realms of accountancy. As with the other aspects of management and planning outlined in this book, budgetary planning ought not to be considered in isolation from the total management system. Even the advanced Planning Programming and Budgeting Systems (PPBS) can be fully effective only if they are introduced as integral sub-systems in the overall management system. The main benefits flow from an explicit recognition that the budget is one of the devices for the co-ordination of the institution as a corporate entity, and from relating the budget to the other elements in the institution's structures and processes.

Considerable change is taking place in the budgetary practices of universities. Traditionally, finance was in general considered and administered as though it had little relationship to the academic or social objectives and operations of a university; for example, "academic" and "finance" committees were firmly separated. Budgeting was largely governed by rule-of-thumb procedures and consisted of bargaining for marginal changes in the previous allocations. Budgets were of the object or line-item type, from which little could be learnt about the costs of activities or programmes. The major concerns and efforts were directed towards keeping the books tidy and

in balance, with little interest in the analysis of the actual use of the money.

In more and more universities, finance is now closely integrated with the academic and social management and planning; faculty committees discuss operations and developments in financial terms, and Finance Officers appreciate that even the structures of their files and ledgers can have important effects outside their offices. Budgets are being increasingly seen as the short-term expression of the institution's overall plan and subsequently the key control mechanism in the implementation of that plan. The usage of formulas, ratios, and cost analysis has risen substantially. Modern technology is being harnessed to assist financial management. The use of computers by universities in the USA is well known, and a recent survey(1) in the United Kingdom demonstrated that from a sample of over forty institutions approximately 75 per cent used computers in their financial management. The budgetary systems of the University of Sussex, described in Chapter 2, and of the University of California outlined in this chapter, illustrate the changes which have been taking place and show that the trends are common to two institutions of vastly different size, of different age, and belonging to different types of educational systems.

The changes should not be underestimated or undervalued, but they have not yet resulted in operative systems which can cope with the problems faced by universities. The next major change in the direction of developing such systems is thought by many to be the adoption of Planning, Programming and Budgeting Systems (PPBS) by universities.

PPBS is a comprehensive planning process which has a programme budget at its core. It provides a disciplined analytical approach to the setting of objectives, to the reaching of agreements on priorities after analysis of the costs and benefits involved, to the resolution of courses of action, to the implementation and control of action, and to the evaluation of the results of action. Eight main facets of the PPB systems and cycle can be discerned.

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1) J. Fielden, University Management Accounting, University of London, 1969.

Institutional Mission

The stating of institutional missions or goals in fundamental terms. Such statements have necessarily to be general in nature; they would include the provision of instruction, the pursuance of research, and the undertaking of public service.

Objectives

The definition of objectives and their specification in terms of quantity and time. Examples of objectives could be to graduate 100 economists in 1972, or to increase the Physical Sciences holdings in the Library by 25 per cent during 1970-71, or to extend the playing fields by 10 acres by 1971, etc.

Programmes

The creation and definition of programmes. A programme is a series of related activities or services, which are in closer relationship with each other than with those outside the programme, and are designed to accomplish stated objectives. Programmes can be vastly different in size and the major programmes have to be subdivided. Teaching is a major programme which requires sub-programmes for each subject or year.

Budget

The creation of an annual programme budget. Traditional university budgets emphasize function and objects of expenditure with line-item accountability. A programme budget emphasizes the object-oriented programmes containing services and activities and estimated related costs. The budget thus more explicitly becomes a policy document since it records how the available resources will be used to attain the stated objectives, and shows the choices that have been made between alternative objectives and programmes.

Forecasting

The projection of the demands for several years ahead. The aim of this element is not to enable the construction of rigid long-term plans, but to attempt to ensure that the best estimates of long-term costs and benefits are taken into account at the point of decision as to whether a new programme should be extended or reduced, and as to what degrees of priority should be accorded to each programme.

Alternatives

The explicit consideration of alternatives is one of the main facets of PPBS. The scrutinising of alternatives before a course of action is approved is no more than common sense; that very often this is not done is a fact of life. To make sure it is done, therefore, sets of rules or procedures must be formulated and adhered to.

Evaluation

At the stage when a new programme is introduced or agreement reached that an existing programme shall be continued, criteria are set by which the programme achievement is to be measured.

Feedback

The transference of experience and information from the evaluation process to the processes of goal setting, objective formulation, and programme determination. Evaluation results in re-assessments, modifications and new insights which re-enter the system and turn it into a continuous cycle of planning and activity.

The advantages claimed for PPBS are numerous. Most of them can be assumed from the above description. A secondary benefit is that it encourages the development of an efficient management information system. It also facilitates relations with government and the public by making understandable the objectives of the institution and by making visible the resources available to accomplish each of those objectives. The fact that the rigorous use of PPBS within a university poses severe difficulties does not significantly reduce the benefits which flow from attempting to do so, or from the implementation of some of its facets. The specification of objectives demands the structural and timely discussion of issues and priorities which otherwise might not be raised until a crisis situation forces them to the surface. The explicit consideration of alternatives and the spelling out of the long-run costs of a proposal reveals much about the management of an institution and the quality of its leadership.

The technical problems of setting up PPBS in depth in a university environment are no more difficult to overcome than is the inertia which prevents major managerial innovation in most established institutions. However, the technical problems are themselves severe. Examples of these include the difficulty of expressing

educational activity in qualitative terms or of reaching agreement on standards or criteria for evaluating the quality of performance. The 1969 1st class honours graduate in Sociology differs considerably from that of 1949 or 1959, but how can we measure the difference, how can we tell precisely whether there has been increased productivity in the quality sense, and how can we separate out the value added by the university as opposed to that added by the secondary school or junior college before the student entered university? The establishment of such measurements is even more difficult in the area of research activity and in the area of public service. How can we measure the contributions which one hundred different faculty members make to several hundred different national, local or professional agencies? A second set of problems revolves around the difficulty of defining separable programmes within a university. This partly derives from the difficulties of clearly specifying objectives and partly from the multi-purpose nature of the units of resource used by universities. For example, individual members of the academic faculty, technicians, and even secretarial and clerical personnel are normally each involved in teaching, research, and public service activities; even if their inputs into those three programmes could be separated out precisely, there remains the problem of the joint effect on both teaching and research of a particular activity of a member of faculty. Given that staff costs normally account for between 60 per cent and 70 per cent of a university's operating budget, this problem of separating out labour inputs into different programmes is a major obstacle to precision in the working of PPBS in a university. There are other problems, such as the assigning of basic university overheads to programmes, but the above examples are a sufficient indication of the severe difficulties that exist.

Nevertheless, serious attempts are beginning to be made to implement PPBS, as illustrated by the approach of the University of California, which is seeking to reconstruct its planning and budgetary systems to make them rationally persuasive to the informed public and also more effective as mechanisms for making wise internal choices. The following summary description of these systems consists of extracts from a paper prepared for OECD by Professor F.E. Balderston, Vice-President (Planning and Analysis) of the University of California.

"In 1969-70, the University of California will have approximately 100,000 students on its nine campuses, and about 7,000 faculty and 38,000 other employees. The total operating budget will be of the order of 672 million dollars, of which about 48 per cent will come from the State of California, 20 per cent from Federal and foundation grants and contracts, and 32 per cent from student fees and other sources.

"A brief review of the planning instruments and mechanisms now in use in the University is necessary as background to current developments. Each campus of the University has an academic plan which expresses its official expectations as to future schools, colleges and programmes and year-to-year projections of undergraduate and graduate enrolment (co-ordinated through the Office of the President with the enrolment projections throughout the system)... Closely linked to the campus academic plan is its Long-Range Development Plan, which indicates the physical lay-out and future facilities of the campus.

"The University-wide academic plan, like the campus plans, is updated periodically and approved in principle by the President and the governing board. This plan contains the approved University-wide enrolments, both undergraduate and graduate, by year for ten or more years, and it spells out the major parameters of growth and programme development for the University as a whole.

"Neither the campus academic plans nor the University academic plan contains resource requirements and priorities. The University's Long-Range Fiscal Programme has been developed to provide, in broad functional categories, the projections of capital and operating funds required over a ten-year interval to realize a path of growth consistent with the enrolment projections. Much more detailed, intermediate-range budgets are prepared annually for a five-year horizon. These budgets, approved by the governing board, represent the University's request for funds from the California State government, and its forecasts of the funds that will be forthcoming from other sources. The State acts only upon the first year of these five-year cycles, and it customarily takes separate funding action, through somewhat different review procedures, for the capital budget and the operating budget."

The foregoing outlines the main features of the systems. The University is now in the process of moving from a function to a programme budget. "There are three major programmes, each with its own measures of output: instruction, sponsored research, and public services. Three supporting programmes are identified: libraries, administration, and supporting services... Each of these programmes and the subprogrammes within it is defined as a cost and budget category. A practical achievement of major proportions is the writing of a computer programme to translate from the existing budget accounting codes to the new format. This computer routine is now operative. Each major programme and each supporting programme is broken into subprogrammes. The instructional programme and sponsored research are broken into discipline categories. Level-of-activity indicators are defined for each of these, one of the obvious ones being the amount of enrolment by discipline major. Identification of the costs of each subprogramme within the instructional programme is a major issue." The problem of allocating faculty time to the programmes and of analysing the joint effects of faculty inputs is being tackled through an intensive interview-based study of a sample of approximately 15 per cent of the faculty. Another approach to the identification of costs with programmes is through the development of a cost-simulation model for the University.

This model was first developed three years ago as an experiment in tracing and estimating the costs of academic programmes by discipline and by level of student. There are three basic problems in such cost-tracing: identification of the costs associated directly with a given programme; use of data which make it possible to estimate induced costs of the programme; and use of rules for the allocation, where necessary, of joint costs... For most of the general campuses of the University, the statistical records of class enrolments have now been compiled so as to serve as input to the cost-simulation. The tracing of induced instructional costs associated with the number of students in a given discipline is a major achievement of the cost-simulation model.

With this model, it has been possible to estimate the costs, as of the existing pattern of activities in each discipline, of providing a year's education to a student who is a candidate for a B.A. degree or a Ph.D. degree in a given broad discipline area.

Eleven discipline groups were used in the original construction of the simulator. Both operating costs and imputed physical facilities costs are estimated.

The cost-simulation model has shown that the annual cost per student varies enormously by discipline, and indeed, that the cost per student in some undergraduate degree majors is higher than in some Ph.D. programmes. By combining the unit cost estimates fro the cost-simulation model with data on graduate persistence and attrition, estimates of the net cost per degree achieved in various disciplines have been derived. The model is not an optimisation model; it is an attempt to record and to understand an on-going system. The University of California fully realises that in regard to another set of problems associated with PPBS in universities, that of measuring results, there are no easy answers, and answers can begin to be formulated only through analysis and experience. For example, the measures of instructional output which will be used in the first version of PPBS at California are conventional: numbers of bacoalaureate and advanced degrees granted, by discipline, together with measures of attrition and some partial indices of quality. "One short-term quality indicator, for the degree recipients in a given year, is the distribution of first jobs to which they go: for Ph.D. winners, the rank and reputation of the colleges, universities, or research jobs to which they are attracted. Another indicator of quality, and one which is subject to debate, is the starting salary on the first job. Some academic departments and some professional schools have kept records of the career progress of previous degree winners, and this kind of longitudinal information is very much needed". However, it is obvious to the University "that the conventional data base needs to be expanded very substantially in order to make possible the evaluation of the impact of education".

With regard to the information base required by PPBS, mention needs to be made of two fields of activity at the University. First, student enrolment projections are of critical importance and the University is "working on a number of aspects of student flows, both to improve the accuracy of prediction under existing policies and to explore the consequence of possible changes in policy". The models need to take into account many factors. For example, "the University is one segment of public higher education in California; the

eighty-five junior colleges and nineteen State colleges have combined enrolment several times as great as that of the University". Some students come directly to a university campus upon graduation from high school; others go first to a junior college or State college, and then transfer. Also, within the University, qualified applicants for first-time admission to a given campus must sometimes be informed that they cannot be accommodated on that campus, or are "redirected". Another factor is the significant amount of inter-campus transfer for students already enrolled. Also, the factor of attendance patterns needs detailed examination since students nowadays interrupt their education for varying periods, for work or travel or other reasons. Equally, persistence and attrition rates are essential for the evaluation of the net effectiveness of academic programmes. All of these factors need to be understood more fully for greater precision to be achieved in the forecasts of the number of student places available each quarter. They can begin to be understood more fully only when the gaps which at present exist in the enrolment and attendance data held by the University have been rectified. The University is constructing several types of student flow models which will have to be in appropriate dynamic forms if they are to yield the kinds of results which are needed.

Secondly, models of faculty hiring, promotion and retention, and retirement and replacement are also being developed, partly because there are significant policy questions to be explored which require the constructing of very long-horizon (30- to 40-year) models. For example, the upward shifts in age-distribution and distribution of rank and pay which must be anticipated under present policies on campuses that have nearly reached the steady state, the cost implications this has, the way in which the administration of salaries and the University's pension system can be modified to produce appropriate flexibility, where flexibility in the institution of new academic programmes is very heavily dependent on the number of faculty positions available to be filled by new appointment each year.

The above is a very brief outline of the major progress being made by the University of California in the fields of planning and budgeting. This progress is significant but, as the University itself emphasizes the aims of the first versions of its new systems fall short of the claims being made by some of the proponents of the

new theories of management. The objective is to understand the institution more fully and to assist decision-making by showing as clearly as possible the costs and consequences of each alternative.

In summary, PPBS provides a goal towards which universities should move; its implementation, which is now being pioneered by California and other institutions, should lead to modifications which will improve its adaptability in the university environment.

CHAPTER 5

THE CAMBRIDGE PHYSICAL PLANNING MODEL

The problems referred to in Chapter 2 have led to a considerable development in the role of space management in many universities. The pressures of increasing student numbers and expanding research activities have led to rises in the demand for space at the same time as financial restraints have placed firmer controls on the supply of space. These changes over the past few years in the demand and supply factors have forced many universities for the first time in their histories to enquire seriously into the utilisation of space. A second factor in the development of space management has been the growing realisation that the nature, design and distribution of space has considerable effects upon the academic and social life of a university community. The expansion of universities has allowed that realisation to be given effect in the planning of the capital developments associated with the growth in student numbers.

The development of space management can be demonstrated by the fact that many universities in the United States now have an office or officer responsible for the collection of data on the nature of space and its usage, for advising on the allocation of that space, and for assisting the office responsible for planning new capital prospects. Also, in the United Kingdom, in addition to several national surveys conducted by the Committee of Vice-Chancellors, there are at least three groups working at the institutional level on the use of space by universities.

The ways in which the developments have taken place can be summarised in four stages. First, the creation of space registers held in a central university office either on visual records or on the computer; such a register usually records the nature, size and

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location of the units of space available, and classifies these units by type of usage and locational zone. Secondly, the undertaking of space utilisation surveys and studies. The studies usually are conducted in the first instance into teaching areas, and are concerned with the nature, frequency and level of occupancy or usage; for example, what classes of students use a particular lecture theatre or laboratory for how many hours per week and what numbers of places are occupied in the theatre. From that starting point the surveys move on to study the usage of the library, the cafeterias, the playing fields, etc. - the next extension is to studies concerned with the traffic of groups within the institution in order that management can have information on flows of users as well as single-frame shots of space usage. The creation of space inventories and the studies of space utilisation have been considerably aided by the introduction of computers into university administration, but a computer is not essential to do the work. As with other aspects of management, the adoption of the attitudes and concepts underlying the techniques represents the main breakthrough. Once a university management begins to regard space as a factor of production which has to be mixed with finance, manpower and equipment to produce outputs, and as a resource which can be used with some degree of flexibility, then the creation of space registers and the search for information on space utilisation will automatically occur - even if the register has to be handwritten by a clerk into a ledger, and the space utilisation studies undertaken by the porters in each building keeping hand-written records of head-counts. One of the main reasons why many universities have not adopted such attitudes towards space is that the externally-imposed systems within which they work set a rigid boundary between capital and operating costs. In such circumstances a university has no ability to regard space and operating finance as interchangeable at the margin. It has no incentive to save on capital cost and it cannot use savings in operating costs to provide extra space. Within a structure which imposes such a rigid and false distinction, it is hardly surprising if the individual institution fails to treat space as one of a range of resources whose mix can be altered to achieve different ends.

Following the two stages of obtaining improved information on space, the third stage in the development of space management is the

adoption of a new approach to space allocation. Previous practice can be crudely described as the granting of space by the institution to departments or other units in perpetuity. Space, at least at the margin, is now increasingly allocated on bases and by methods similar to the allocation of operating cost resources. For example, the use of ratios is increasing to set guidelines for internal space allocation: p square feet of office space per clerk, q square feet per student bedroom, r square feet laboratory space per student, s square feet of large-group teaching space per student, etc. Also, space budgeting is becoming a more common method of adjusting the annual supply of space to departments and other units. The University of Sussex planning process, for example, includes an annual space allocation exercise which adjusts allocations to meet the needs of other change factors. If it has been agreed in the academic plan that the Philosophy subject group should decline in terms of faculty and student numbers, whereas the History group should develop, then adjustments in space allocation must follow. Similarly, the University of Konstanz plans to include space as one of the resources allocated to research groups and which have time limits set to the allocation. Another aspect of this third stage of development is the growth of centralised day-to-day control over specialised units of space. This is particularly true for multi-purpose large-group teaching spaces (lecture theatres, seminar rooms, and some types of laboratories), where space utilisation factors, allied with increases in interdisciplinary teaching and the need efficiently to distribute new and expensive audio-visual aids, have led to central control and timetabling of the use of these spaces in many universities.

The fourth stage is the resulting use of the space content, the utilisation of information in the planning of new capital developments, and the relating of the procedures for the allocation of existing space to capital development and site planning. The uses in capital planning of information on the content and utilisation of the existing stock of space are obvious; a new building cannot be properly sited unless the information on the campus flows of its likely users is studied; the amount and design of laboratory or lecture theatre space that needs to be included in the next marginal phase of development can be determined only by an analysis of the present stock and its utilisation, and of the categories of students

in which expansion is to take place. If the uses of such data are obvious, it is equally apparent that in the past the majority of universities have planned their capital development without having any systematic information on that data. Another of the effects of procedures which marginally adjust space allocation each year is a demand for greater flexibility to be built into the capital developments. If space is to be regarded as a resource whose allocation can be altered through time, then individual buildings need to be more adaptable in their physical structures.

The foregoing is a very brief outline of some of the developments which are occurring in the management of space by universities. The developments are by no means universal and they do not always follow the pattern of the above four stages. Three summary points need to be made about the changes in space management, and their nature is common to the points made on the other aspects of management described in this book. First, external pressures or stimulae have provided the main motive force for change. In the United Kingdom, for example, capital costs and plant utilisation are national issues which may have even more significant effects upon individual institutions than those which have been outlined above. These issues are, for instance, leading to proposals for an extension of the teaching year from thirty to forty weeks and for students to enter their "local" university in order to reduce residence costs in universities. Secondly, the management and planning of space and physical plant ought not to be considered in isolation from the total management system of an institution. The space inventory and the utilisation studies should form part of the integrated information system of the university. The space allocation procedures should form part of the commonly structured and timetabled annual operational planning and budgeting system of the university. Capital development planning should be closely related to fiscal, academic and social planning in one comprehensive planning process. A building should first be considered as a resource, subject to the same attitudes and procedures as other resources; the fact that it can also be an aesthetic monument does not cancel out that prior view.

Many techniques are involved in space management: for example, critical path analyses can be used in the planning and control of construction work. However, rather than catalogue these techniques

and their usage, the remainder of this chapter outlines one approach to the problem of integrating space planning with the other aspects of management and planning in an institution. The approach lies in the research work of Messrs. Bullock, Dickens and Steadman in the School of Architecture at the University of Cambridge. The remainder of this chapter is a summary of a paper prepared for OECD by this research team; a detailed interim report on the project has been published(1).

Their work concentrates on physical planning, but in the full realisation that this cannot be treated independently of the other aspects of institutional planning: if such studies were pursued in isolation they would fail "to take into account the crucial effect of parameters outside their particular scope, and consequently be unable to provide the information with which to optimise in terms of the whole"(2). The aim of the research is to construct mathematical computerised models of the various relationships between the different parameters which affect the physical aspects of university planning. The approach has much in common with the kind of models that are being developed for use in urban planning. Universities are less suitable environments for the use of modern management techniques than are industrial firms or other forms of organisation, but it is refreshing to point out that in the field of physical planning universities are more structured, more controlled and more homogeneous entities than are cities; and those responsible for their planning and direction are in a position to collect more detailed information on their population and activities. Although the Cambridge team is using information from real situations in the construction of the models, the aim is to produce a tool capable of representing a wide range of specific situations.

The Cambridge work falls into two major fields. The first is a description of the activities of the university, a model representing the functioning of the institution in terms of the flows of students, the patterns of teaching, the organisation of social facilities and so on. The second is concerned with the investigation of alternative

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1) A Theoretical Basis for University Planning, Nicholas Bullock, Peter Dickens, and Philip Steadman, April 1968, Land Use and Built Form Studies, Cambridge.

2) Ibid.

ways of organising the physical lay-out of the university at three different levels. The largest scale is concerned with alternatives for the siting of different elements of the University within the city. The intermediate scale examines alternative lay-outs for sites and the relationship between different facilities on the same site. The most detailed scale is concerned with alternatives for the siting of different elements of the university within the city.

The team's approach envisages a form of "dialogue" between these two parts: after the values for the parameters defining the activities of the university have been determined, it is possible to match physical planning proposals to these activities. The success of the physical plan is then measured by a number of criteria, and the results of this evaluation might then lead to the alteration of the initial value set for the model. In the light of the first evaluation, it might then be desirable to try some new policy for, say, student numbers, or to revise the physical planning proposals. This process could be repeated until a satisfactory "matching" of activities with stock of buildings were achieved.

In the discussion of activities, a distinction must be made between those "scheduled" activities which are governed by the timetable - lectures, classes and laboratory periods - and what the Cambridge team have called "non-scheduled" activities, which comprise all other activities outside the hours of formal teaching. By the term activities is meant simply "who is where when", or "who is going when from where to where".

The first reason for representing "scheduled activities" is to provide some systematic means of estimating the amounts of space required for teaching. Traditionally this has been calculated on the basis of a "utilisation factor"; but while this may be derived for an existing situation it provides no basis for predicting demand in a new situation. To overcome this difficulty the Cambridge team have set up a timetable programme which will make it possible to schedule different patterns of teaching, and thus to simulate <u>experimentally</u> the effect of various constraints on intensity of use and space requirements.

It is hoped that these investigations will include the study of the effect of relative complexity of course structures, described by various graph theoretical measures, on the possible levels of

utilisation, the economies of the centralised allocation of scheduled space, and the simulation of the intensity of use over time for changing numbers of students and varying teaching loads.

The timetable also provides the starting point for the simulation of non-scheduled activities as a whole. The importance of the representation of non-scheduled activities lies in the possibility of showing how an administrative or planning decision at one point, say on the location of residence, must be related to many other decisions, for example, concerning provision of car parking space, or of facilities for dining and private study. Only by representing the activities for the university as a whole can the effects of alternative locational policies be related to the needs for space in different types of accommodation, and only in this way can the effect of increasing the provision of space in one facility be related to the resultant use in another.

At present there is little documentation of patterns of non-scheduled activities, either for Great Britain or elsewhere, compared to the wealth of data available on formal teaching. In order to set up a model of this type, the Cambridge team propose to carry out surveys in two universities in which the activities of a sample number of students would be recorded in "diary" format throughout a week. Each respondent would enter in his diary an account in considerable detail of his activities and their locations over the whole week. This diary survey would be complemented by a complete survey of site and buildings; and by matching the two it is hoped to determine those characteristics of the physical lay-out of facilities which have an effect on students' activities.

In constructing the activities model the approach has been to treat the timetable as a series of points in time at which the student's activity and location are determined in advance. Once the timetable is determined, the choice of other activities is taken to be dependent on a "time budget" for each group of students. The "time budget" shows the overall proportion of time spent in different activities (other than formal teaching) by students with the same identifying characteristics.

For the purpose of the simulation it is assumed that the student starts the day in his place of residence. The activity for the the first time-period is then selected randomly from the "time budget"

for the appropriate time of day and the relevant student group. Initially it has been assumed that this random representation of the choice of activity, as a Monte Carlo process, is legitimate. An alternative method of simulating the selection of the activity for the next time-period would be by means of a Markov process, as widely used in the simulation of travel behaviour at the city and regional planning level. In this case it would be assumed that the choice of activity is not random, but has a probability determined by the selection of the activity in the preceding time period. But, according to the Cambridge team, any decision as to which approach is the more appropriate must await the results of the surveys of students' activities.

After selecting an activity for the next time-period the student is assumed to choose an appropriate location for that activity. Following the "principle of least effort", it is assumed that he will choose the nearest facility. If the first location is filled to capacity he then proceeds to the next nearest and so on. At some point in this unsuccessful search for a location the activity is abandoned, and a new one selected.

In future studies they hope to make the mechanism in the model that represents the student's choice of location more sophisticated. Instead of simply choosing the "nearest" facility, the student's choice might be represented by sampling a trip distribution function to give the distance that he would travel to a particular type of facility. Alternatively, his choice might be subject to some "gravity" effect: the choice of library, for example, might be affected by the size of the collection and the probability of finding a particular book. But in the choice of location for some activities - for convenient shopping, or laundrettes, say, the student might still be expected to go the nearest facility.

Clearly no attempt can be made to model the activities of individual students and the way in which they organise their activities. However, the model can reproduce the effect of a number of general constraints on the student's pattern of activities. For example, one of the more important problems to overcome in the form of the model is the representation of the effect of an activity determined for a future time period (t+2) on the selection of the activity for the time period (t+1). Some attempt has been made to avoid the

difficulties that this poses - by associating with the proportion of time spent in different types of activities in the "time budget" another distribution representing the duration of each activity for different probabilities of its occurrence. Thus, if the activity "sport" is selected, with a duration of two hours, for the next time period (t+1), and a class is scheduled for the same student in time period (t+2), "sport" would be rejected and another activity selected instead.

The results of the model of "non-scheduled" activities would provide essentially two types of information. First they would provide a basis for the calculation of required capacity in facilities such as dining rooms or the library by indicating the numbers of people using these facilities at different times of the day, and by showing the effects of increasing or decreasing the provision of space on the numbers of students using the accommodation. Secondly, they would provide information on the patterns of movement between the various elements of the university, and thus make it possible to predict the volume of traffic along particular routes for alternative locational arrangements and different site lay-outs.

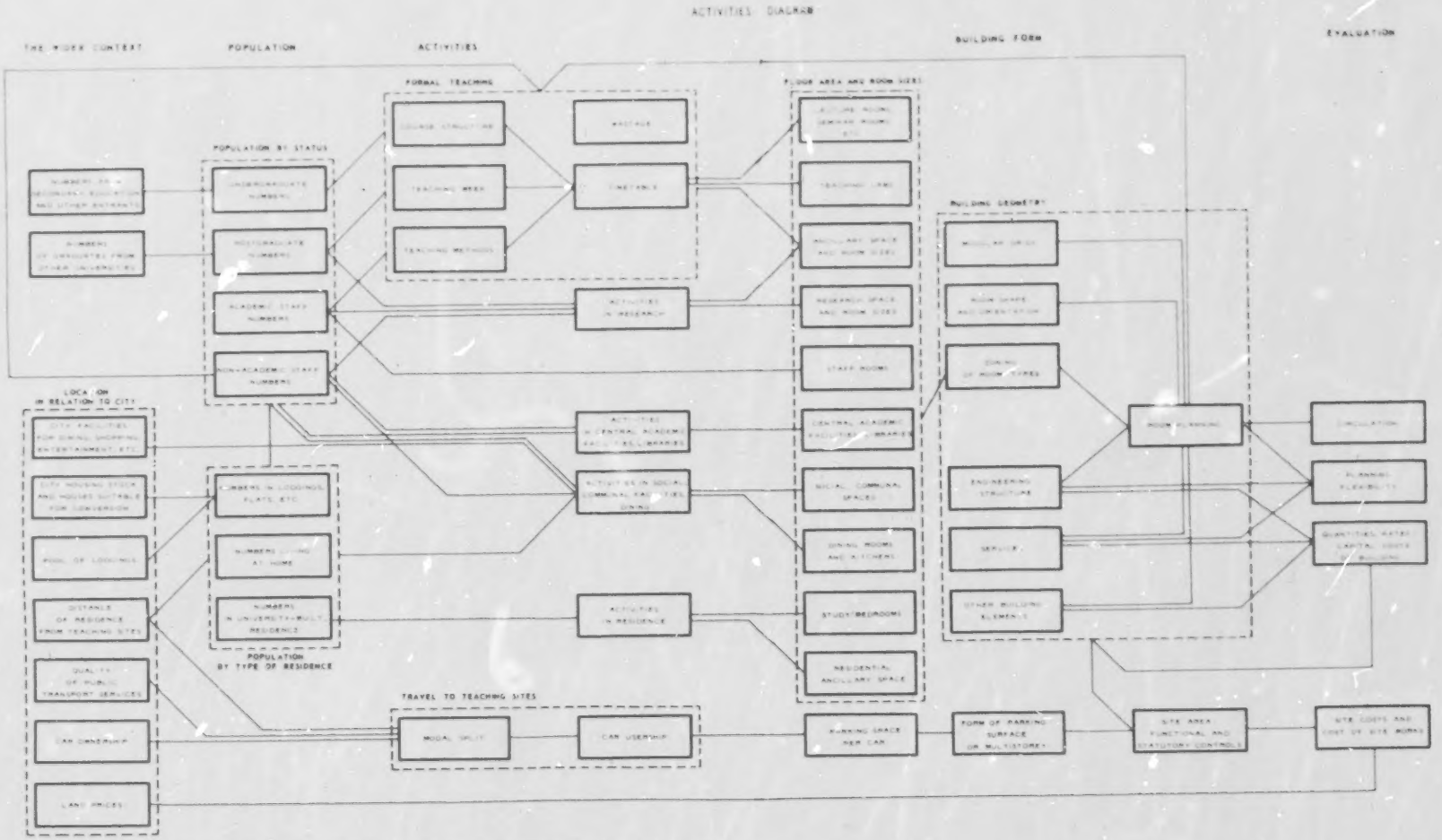
By simulating the pattern of activities for the university as a whole, in a particular case, it would be possible to calculate the number of people using the library, for example, at different times of the day for a typical week. If in a second case the number of people in residence on the central site were increased, this would have the likely effect that students who would in the first example have used the library for private study would now work in their place of residence. In turn, this might either permit other people to study in the library who previously had been unable to work there because of overcrowding; or it might alternatively permit a reduction to be made in the number of reading places provided in the library. This illustration is necessarily simplified, but it does show the critical importance of an overall model of activities in relating locational decisions to the planning of sites, and in demonstrating the consequences of these planning decisions on the use of facilities.

For the modelling of the buildings and sites of the university the Cambridge team are developing two complementary approaches. The first involves the subdivision of the total site into a number of separate "cells" by means of a superimposed grid, and the tabulation

of floor space totals for different use categories in each grid cell. The dimensions of the cell might be, for example, 50 metres by 50 metres. This approach suggests the matrix formulation typical of urban models. The problems of such a small areal unit will be that since its dimensions correspond roughly in order of size to the typical overall plan dimensions of single university buildings, curious effects may arise from the fact that a building may fall partly in one cell and partly in another. Also, where for an urban model the use of a system of large-scale land area cells may be justified, implying as it does the simplified representation of the city as a two-dimensional plane, at the scale of a 50 or 100 metre unit, the particular three-dimensional form of the buildings will assume much greater importance. A series of experiments with grid dimensions of different sizes may show what the problems are in practice.

Complementary to this first view is the second approach which emphasizes the structure of the system of pedestrian and traffic routes forming the "skeleton" of the lay-out of site and buildings (upon which the "flesh" of the floor space hangs), rather than the distribution of floor area by units of site area. The route structure would be represented by a series of "nodes" (junctions where routes meet) joined by "links" of various lengths (the routes themselves); and such a model would again lend itself to matrix formulation in a manner similar to the models used in highway design. The links would correspond in reality to both the horizontal routes - paths and roads crossing the site, and corridors inside buildings - and to vertical routes, that is lifts and staircases; the length of each would be measured in terms of an average time required to traverse that route (by different modes of transport, possibly) rather than as a length in real space. The whole structure of such a model would be topological rather than geometric. It would be possible for information of floor-space totals to be incorporated by attaching this to the relevant "terminal nodes" - the tips of the branches of the tree-like route structure - which might correspond either to the doors of individual rooms or the entrances of buildings, depending on the level of detail to be represented.

The work being undertaken by the Cambridge team forms part of a broader programme of research at the Centre for Land Use and Built Form Studies in Cambridge. Much of the architectural work originally



Reproduced from A Theoretical Basis for University Planning Report No. 1 – Land Use and Built Form Studies, University of Cambridge, School of Architecture

envisaged in the study of universities has now been taken over by a research team working on the problems of office buildings. D.U. Hawkes of that group is producing, in collaboration with other specialists, a co-ordinated suite for computer programmes designed to measure the environmental characteristics of spaces in buildings. Levels of daylight and artificial light are determined from data on windows, fittings and wall surfaces; calculations are made of heat loss and gain, air conditioning requirements and acoustic properties of space are measured. O.P. Tabor, of the same group, has made a special study of pedestrian circulation in buildings. Work is also going forward on the description and measurement of various types of structural and service systems.

At the city scale, a realistic context is provided for the study of alternative locations for teaching and residential facilities by the work of the Urban Systems Study. Starting from the work of Lowry and Garin, they have developed a computable model of the urban spatial structure which has already been tested successfully with data from a number of towns. The development of their work to treat different socio-economic groups and to describe the town at the more detailed level of the 500 sq. metre cell is complementary to the proposed direction of the research on universities, at a larger scale.

Finally, the work being undertaken by Messrs. Bullock, Dickens and Steadman at Cambridge is architecture research and planning. It demonstrates the importance and relevance of space planning to universities; but it also emphasizes the need for architects, cost planners, academic faculty, general administrators and students to collaborate in the construction of models and mechanisms and in their use in decision-making.

CHAPTER 6

GENERAL PLANNING SYSTEM OF TORONTO UNIVERSITY

Previous chapters have discussed the planning process, information systems, budgetary systems and physical planning models. This chapter looks at an example of the development of a comprehensive institutional planning system.

The development of general planning systems which cover the institution as an entity as well as meeting the needs of faculties, departments and centres, and which are relevant to most aspects of management and planning, is only in its infancy. Several such models should become operational in the near future in American institutions but none of them is yet concerned with complex universities, which have varied and large-scale research and other activities in addition to teaching. This chapter presents one example of the development of general systems. The discussion of the uses and merits of such models is contained in Chapter 7. The example is provided by the University of Toronto, which has been experimenting with the model for five years. The Systems Research Group, led by Professor Richard W. Judy and Dr. Jack B. Levine, has worked as a team of technical consultants at the University of Toronto, and the following summary of its work is a series of linked extracts from a paper prepared by the Group for OECD.

The group began working on comprehensive analytical methods for planning university systems (CAMPUS) in 1964, first attempting to build a macro-econometric model of the costs of Canadian universities. The project was abandoned after a very brief time and was replaced by work on an institutional cost simulation model, patterned on the kinds of simulation models that had been used to estimate the costs

of advanced weapons systems and other air space systems. The experimentation with the design of these models was begun by building a test case model in 1965 (CAMPUS I) of the Faculty of Arts and Science at the University of Toronto. Thereafter, in 1966, the pilot study was used as a basis to develop a full-scale implementation (CAMPUS II) of this kind of modelling at the University of Toronto, for which a new group, the Office of Institutional Research, responsible to the President, was created. Work on CAMPUS II is continuing. In parallel and related to that work, the development of a resource planning cost estimation model for application in the Faculty of Medicine at the University of Toronto was commenced in 1968. The Group received a grant from a foundation to convert the campus-type modelling techniques into a macro-language which would make it possible to construct models of this kind for a wide variety of institutional circumstances. One of the results of that grant has been the development of CAMPUS V, a completed software package which is now operational.

The above outlines the historical progress of the work of the Group. In terms of the content of the work, the line of development is that the approach to comprehensive analytical methods of planning in a university system began with the simulation model, became increasingly concerned with integrated information systems, then with PPBS, and finally became involved with master planning systems. That experience emphasizes one of the points which recurs throughout this book - that in the end, model-building, information systems, budgetary systems and planning systems are not capable of being developed fully except within the framework of a total management system.

The four main components of CAMPUS are illustrated in Diagram A. In regard to the integrated information system, the work is seen in four stages. The first stage is a study to determine the kinds of information needed to make decisions at various levels in the university; the second is to determine the kinds of information needed to go into the files, to see whether there should be other (or perhaps fewer) files, and to design the file structures. The third is the development of the kind of software needed to maintain the files on an up-to-date basis; and the fourth stage is concerned with hardware selection. The Group is at stage two at the University of Toronto at the present time.

The second component of CAMPUS is the master planning system which at present is strongly oriented towards physical planning; determining the physical space needs, matching these against space availabilities and attempting to replace a static kind of physical facilities planning with a much more flexible and up-datable type of facilities planning which makes it possible to adjust physical plans as circumstances change.

The third component is the programme planning and budgeting system. The major aim of PPBS at the University of Toronto is to provide a vehicle for encouraging decision-makers to think more explicitly about their objectives. The fourth component is the computer model, and Diagram B gives an indication of the way it operates, i.e. by first looking at the various programmes in which the student body is enrolled (extension courses, part-time special courses, undergraduate courses). While in these programmes the students engage in activities, these are defined as any set of resources that come together for a particular period of time; they have certain attributes (number of hours per week, teaching methods used, class sizes used, etc.). The activities then place loads on various departments (e.g. research centres and institutes, academic departments, extension departments). The departments need resources (e.g. staff, space, equipment) with which they can meet these loads, and they need to make calls upon common services (e.g. the staff and student support departments and administrative departments shown on the chart). The chart is not a replica of the way the simulation model actually functions, but it represents a schema of the way in which conceptually the load is developed.

The model can be used for many purposes; three examples will serve for illustrative purposes. One is to employ a single simulation: to input just one set of conditions and to explore the consequence of that set of decisions. The second is to do a similar thing over time, but to build some experiments into the input data which cause one or several conditions to change as time goes on (e.g. slowly changing class sizes, changing teaching loads). The third is to programme analyses into the models in order to run a number of experiments without making explicit data changes but using search and sub-routines of the model to accomplish the changes; for example, the university may be faced with a budgetary cut and the model could

look for a set of conditions with respect to a couple of variables which would allow the university to meet the cut.

The simulation itself is composed of four main parts. First of all simulation is done at the departmental level, and costs are built up from the activities to the departments. The next level is the faculty, and this sums up all departmental costs to the various affiliated faculties and brings in various additional faculty costs (e.g. the Dean's Office). Thirdly, at the university level and this gives the total cost structure of the university. Finally, the costs from the various levels (the university, the faculty, and the department) are costed back to the various programmes. There are four main types of output report: the student report (which tells how many students, what academic year they are in, what the next enrolling load will be), the staff report (academic, administrative, clerical, etc.), the space report (e.g. classrooms, laboratories, etc.), and a fourth report on other resources required (e.g. equipment). All four types of output report are available at the university, faculty and departmental levels, and the reports become more detailed at the larger loads. There are also output reports on the programmes of four types - a student report, an operating costs report, a report on programme resource loads generated by activities (for example, for a particular activity in economics the report shows the programmes which are placing a load on that activity and the share of costs which they should bear) and a report on resource loads allocated by cost centres (e.g. the departments from which the programme costs are coming).

The output reports referred to provide the university with an enormous amount of information at the point of need. Many further improvements are being worked upon by the Group; for example, reports which display information over time rather than for a fixed point of time, and displays on an interactive device (e.g. a cathode ray tube) to allow conversations to be held with the model.

As mentioned earlier, the CAMPUS methodology from 1968 has been applied to the planning of the expansion and restructuring of the Faculty of Medicine of the University of Toronto. The first step in the work was the establishment of the Health Sciences Functional Planning Unit under the directorship of Richard Wilson, M.D. The work of this Unit has led to the development of a series of related

models: an undergraduate education model, a speciality training model, a medical staff model, a calculation of indirect resources and conversion to unit costs model, a patients record information for medical education requirements model, and a calculation of patient and hospital education resources model. Diagram C illustrates the relationship of the models.

The Health Sciences Functional Planning Unit represents a genuine and important bringing together of a team of model-builders and analysts, under a doctor, to work with students, teachers, curriculum planners, research workers and administrators on the whole range of problems being faced by them as a group. The Unit's models enable the planning group in the Faculty of Medicine to assess in detail the resource implications (staff, space, equipment, patients, etc.) of changes in the student numbers and curricula. The models enable the administrators to evaluate the input of prepared educational policies and plans upon teaching and research faculty, teaching facilities, the budget, etc. Deans and heads of departments can use the models and the other services provided by the Unit to stimulate the effects of changes in curricula or to plan a more effective use of faculty time.

The foregoing is a very brief and crude outline of the CAMPUS methodology; it is hoped that the outline gives readers a notion of the range of the models being developed by a Group which is now well advanced in the application of model-building techniques to the management and planning problems of a university.

In the context of the themes of this book, three points can be made about the experience of the Toronto Group. First, the Group began simply as model-builders, and probably had an exaggerated idea of what models by themselves could accomplish. Over time, it has had to become more interested and more involved in information systems, budgetary structures, planning processes, etc. The Group is also more cautious of the claims which can be made at this point in time for the uses of models, partly because of technical limitations and partly because usage depends upon their acceptance by and integration into the decision-making structure.

Secondly, a fully integrated general model has not yet been implemented for the University of Toronto. The reasons for the failure

Diagram A

CAMPUS COMPREHENSIVE ANALYTICAL METHODS OF PLANNING
IN UNIVERSITY SYSTEMS

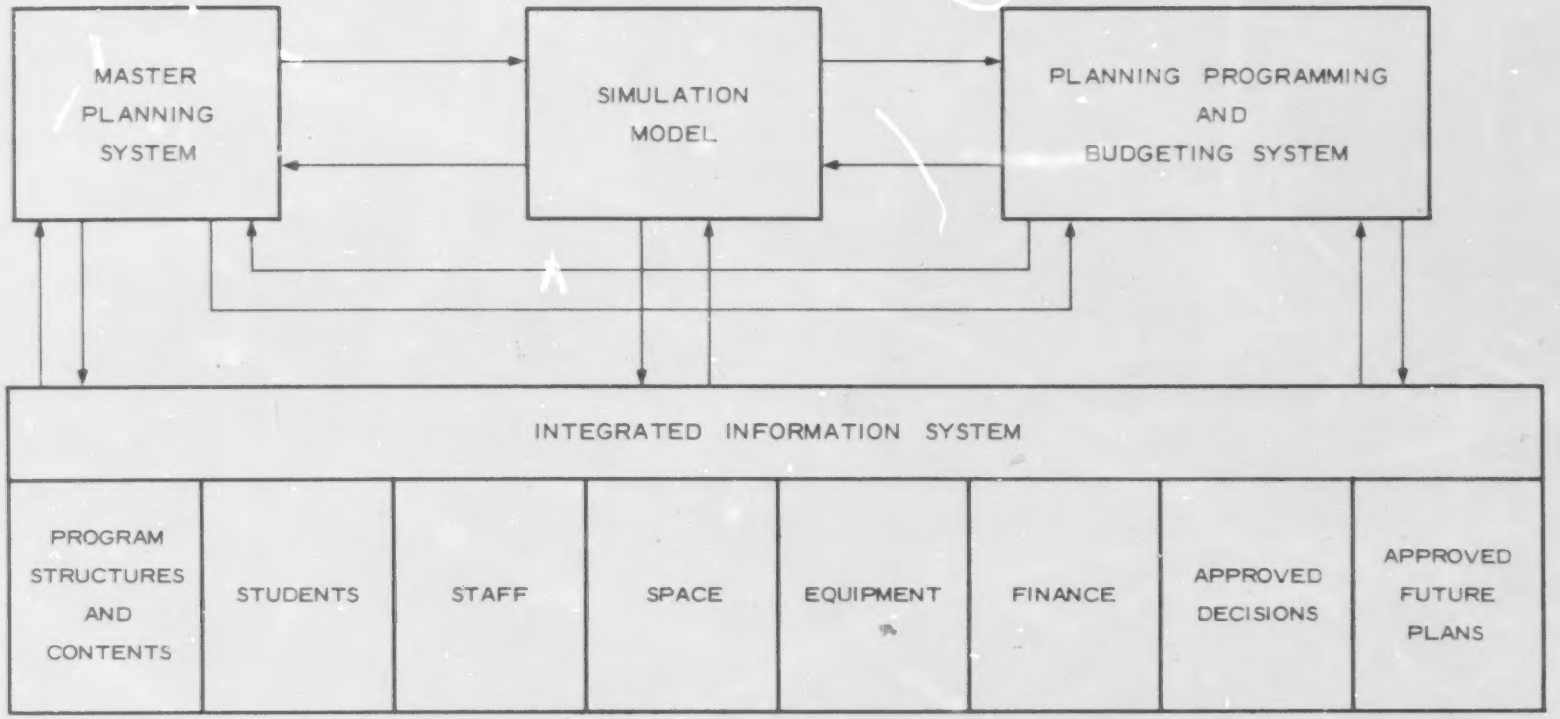


Diagram B

SCHEMATIC OF LOAD DEVELOPMENT

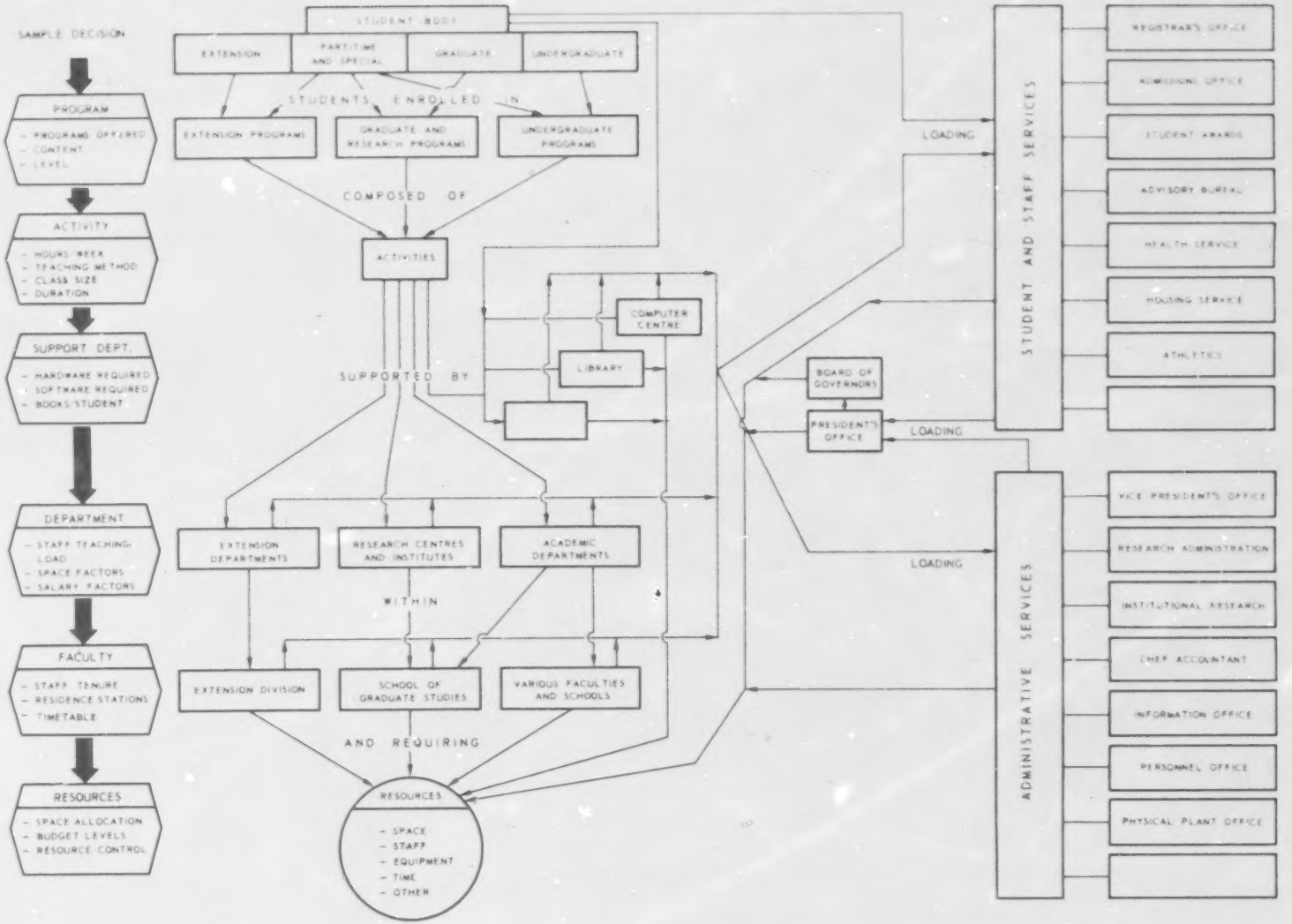
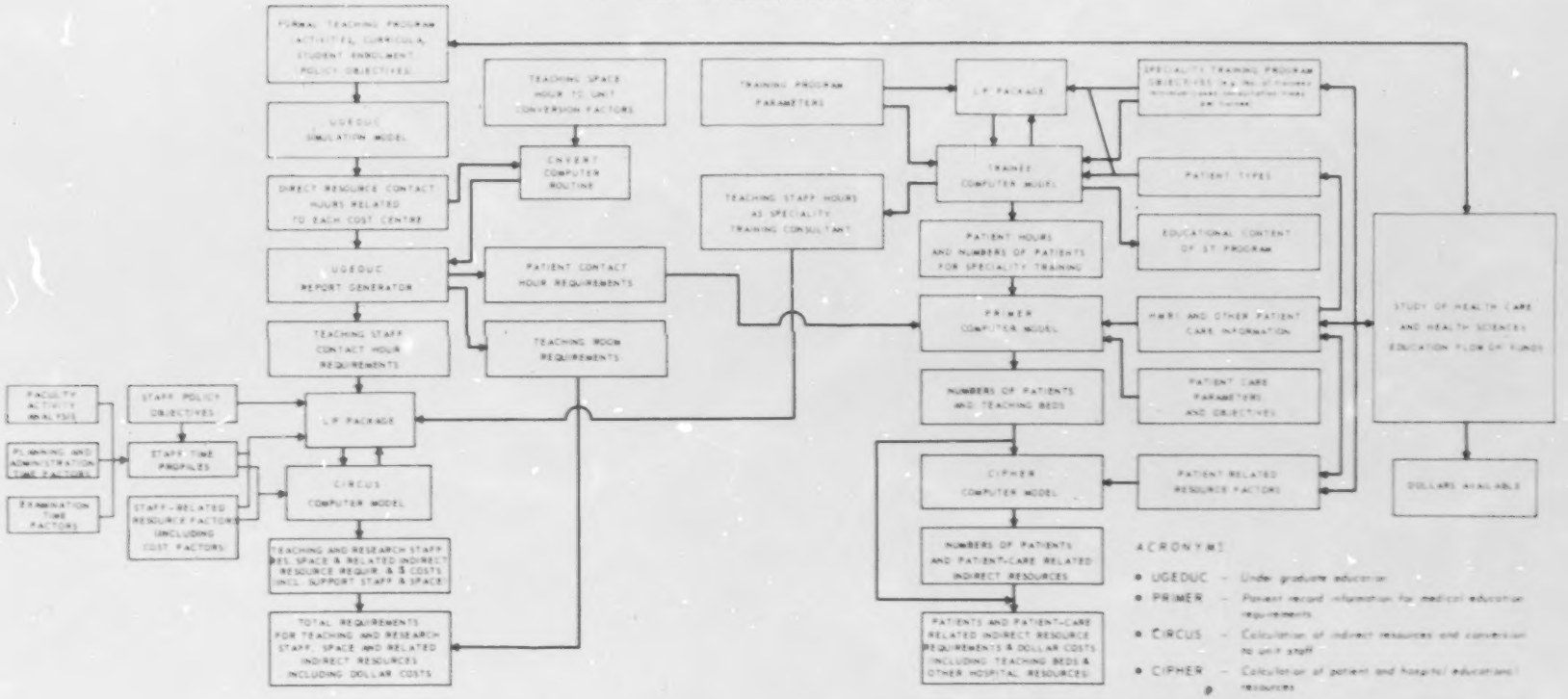


Diagram C

HEALTH SCIENCES RESOURCE REQUIREMENTS
SIMULATION MODELS SYSTEMS FLOWCHART


FORMAL TEACHING PROGRAM (ACTIVITIES, CURRICULA, STUDENT ENROLMENT, POLICY OBJECTIVES)
UGEDUC SIMULATION MODEL
DIRECT RESOURCE CONTACT HOURS RELATED TO EACH COST CENTRE
UGEDUC REPORT GENERATOR
TEACHING STAFF CONTACT HOUR REQUIREMENTS
TEACHING SPACE HOUR TO UNIT CONVERSION FACTORS
CNVERT COMPUTER ROUTINE
PATIENT CONTACT HOUR REQUIREMENTS
TEACHING ROOM REQUIREMENTS
FACULTY ACTIVITY ANALYSIS
PLANNING AND ADMINISTRATION TIME FACTORS
EXAMINATION TIME FACTORS
STAFF POLICY OBJECTIVES
STAFF TIME PROFILES
STAFF-RELATED RESOURCE FACTORS INCLUDING COST FACTORS
LP PACKAGE
CIRCUS COMPUTER MODEL
TEACHING AND RESEARCH STAFF REQ. SPACE & RELATED INDIRECT RESOURCE REQUIR. & $ COSTS INCL. SUPPORT STAFF & SPACE
TOTAL REQUIREMENTS FOR TEACHING AND RESEARCH STAFF, SPACE AND RELATED INDIRECT RESOURCES INCLUDING DOLLAR COSTS
TRAINING PROGRAM PARAMETERS
TEACHING STAFF HOURS AS SPECIALITY TRAINING CONSULTANT
LP PACKAGE
TRAINEE COMPUTER MODEL
PATIENT HOURS AND NUMBERS OF PATIENTS FOR SPECIALITY TRAINING
PRIMER COMPUTER MODEL
NUMBERS OF PATIENTS AND TEACHING BEDS
CIPHER COMPUTER MODEL
NUMBERS OF PATIENTS AND PATIENT-CARE RELATED INDIRECT RESOURCES
PATIENTS AND PATIENT-CARE RELATED INDIRECT RESOURCE REQUIREMENTS & DOLLAR COSTS INCLUDING TEACHING BEDS & OTHER HOSPITAL RESOURCES
SPECIALITY TRAINING PROGRAM OBJECTIVES
PATIENT TYPES
EDUCATIONAL CONTENT OF ST PROGRAM
HMRI AND OTHER PATIENT CARE INFORMATION
PATIENT CARE PARAMETERS AND OBJECTIVES
PATIENT-RELATED RESOURCE FACTORS
STUDY OF HEALTH CARE AND HEALTH SCIENCES EDUCATION FLOW OF FUNDS
DOLLARS AVAILABLE
ACRONYMS
• UGEDUC – Under graduate education
• PRIMER – Patient record information for medical education requirements
• CIRCUS – Calculation of indirect resources and conversion to unit staff
• CIPHER – Calculation of patient and hospital educational resources

of a highly-qualified team to implement an institutional model are various. One of the main reasons, however, must be that the team has been regarded as a research team grafted onto the existing structures of management rather than as an integral part of the institutional structure. Institutional model-building should be part of the total management structure. The commitment to it and the involvement in it should cover all the units; new agencies, such as the Systems Research Group or the Office of Institutional Research may have to be created but their creation and work should be the concern of the institution as a whole and not just of the President's or Vice-Chancellor's Office.

Thirdly, the experience of the Group confirms that the main problems of innovation in the field of management in the university environment are not technical; they are people problems. Universities are institutions in which the decision-makers have not historically been aggressive innovators. However, the experience of HSFPU illustrates that these difficulties are surmountable, provided that general managers of the quality of Dr. Wilson can be recruited. HSFPU is embedded in its environment. The mathematicians and analysts, for example, enrol as medical students to be fully aware of the activities they are helping to plan and manage. HSFPU has not only led to improved decision-making which is of benefit to faculty, students, patients and administrators alike but it also claims that the financial savings resulting from its work represent over one hundred times the investment. These savings arose in the capital field and such [illegible] pay-offs cannot be expected to keep recurring; but the fact that net savings of any size have occurred is sufficient justification for other institutions seriously to consider the experience and operations of HSFPU.

As mentioned at the beginning of the chapter, mathematical models have been developed to cover specific ranges of activity within a university. They range from relatively simple equations and analyses to more complex optimisation, cost estimation and resource allocation models.

CHAPTER 7

USE OF MODELS IN INSTITUTIONAL MANAGEMENT

This chapter discusses the role of mathematical models in the university environment; a number of examples of such models were presented at the Conference.

The word model is used here to refer to the mathematical representation of an institution. In this sense model-building is the construction of a set of equations which express the activities of the institution in terms of a relationship between variables which are controlled by management and those which are not.

The model-building approach to management stems from the fields of economics and operational research, and its application has been considerably enhanced by the development of computer science. The study of economics has always been largely through the creation of quantified representations of behaviour, i.e. models. Research in the natural sciences has also used models extensively, and the application of these methods to the problems of war administration at the time of the creation of the digital computer led to the development of operational research. Thus, ideas which first emerged from university faculties were used for national economic or defence purposes, were later adapted for use in industry and commerce and are now being applied to educational systems and institutions.

The building of a model requires an institution to: be explicit about its objectives, classify its activities, place quantitative values upon its objectives and activities, realise the interrelated nature of its internal units and understand the limits imposed by its external environment. It can be demonstrated that educational institutions are not so dissimilar to economic systems or industrial

firms that model-building yields no advantage to them. The analogy with the production process can help universities to improve their efficiency even though it cannot be carried anything like as far in terms of models in universities as it can in industries and firms. A closer analogy is that with economic policy, and the following paragraphs summarise a view of that analogy put forward at the Conference by Dr. Abdul Khan of the OECD Secretariat:

The theory of economic policy is based on a model of the economy describing a system of structural relationships connecting all relevant variables. One set of variables is regarded as exogenous in the sense that the values are given from outside. The other set of variables is considered as endogenous since the values are determined within the system. Some of the exogenous variables are under the control of the policy-maker and are called instruments and can be manipulated to obtain desired values of the endogenous targets. In addition there are a number of 'data' variables which cannot be controlled by the policy-maker. Finally, the solution of the model will generate values of other variables which may not be of immediate concern and, therefore, are regarded as side-effects.

A similar reasoning is applicable to the formulation of a quantitative policy for a university if the instruments and targets, as well as the interrelationship among variables, are specified. For example, financial aid is an instrument to attain stipulated targets of graduation numbers. But, since the relationship is far from direct, models are constructed to trace the effect of changes in this instrument variable on the target variable through an interacting mechanism of relating enrolment distribution, laboratory and teaching facilities, classroom credit hours and so on as well as student propensities and behaviour. This Tinbergen-type reasoning assumes the university administrator as a target-seeker with fixed targets postulated in advance. But there is an alternative viewpoint. Instead of a fixed-target approach, one can use a preference function which will enable the formulation of the problem in terms of mathematical programming. The solution to a mathematical programming problem yields a maximum value of the preference function under stipulated constraints. The solution itself is in terms of both quantity and price because of the 'principle of duality'.

Under simplifying assumptions we have the following mathematical formulation:

Let m represent the number of constraints, N the number of variables representing activities and M the number of slack variables. The slack variables transform the constraints stated as inequalities into equations. For example,

$$\sum_j \sum_k \sum_l a_{ijkl} x_{jkl} \leqslant b_i$$

becomes (after the introduction of slack variables x_i)

$$\sum_j \sum_k \sum_l a_{ijkl} x_{jkl} + x_i = b_i$$

where h is the constant on the right side of the constraints. Then the total number of variables is n where

$$n = N + M$$

Now the following notation is introduced:

a_{ih} is the coefficient of the h-th variable in the i-th constraint.
b_i is the constant of the i-th constraint.
c_k is the unit cost of the h-th variable.
x_h is the level of the h-th variable.
A is the m-row, n-column matrix of coefficients a_{ih}.
b is the m-component vector of the constants b_i.
c' is the row vector of the costs c_k.
x is the vector of the activity levels (x_1, x_2, ... x_n are its elements) which is called the 'programme'.

Because of the linearity assumption both for the constraints and for the preference function we call this a linear programming formulation. Such an optimisation framework can be applied at both the level of a total education system and at the institutional and/or sub-institutional level of the university.

At the latter micro-level the linear programming model is applied, say to the problem of allocating resources between research

and teaching(1). Let us denote (for an academic department) the following symbols:

$P_{jk}^{\ i}$ is the price of the i-th staff member in the k-th section of the j-th course.

$C_{jk}^{\ i}$ = 1, if the i-th individual teaches the k-th section of the j-th course and zero otherwise.

$P_{Rk}^{\ i}$ = price of the k-th unit of research by the i-th staff member.

$C_{Rk}^{\ i}$ = 1 if the i-th individual produces the k-th unit of research and zero otherwise.

The preference function is written as

$$\sum_i \sum_j \sum_k P_{jk}^{\ i} C_{jk}^{\ i} + \sum_i \sum_R P_{Rk}^{\ i} C_{Rk}^{\ i} = \max.$$

subject to

$$\sum_j \sum_k C_{jk}^{\ i} + \sum_k C_{Rk}^{\ i} = B_i$$

$$\sum_k \sum_i C_{jk}^{\ i} = B_j$$

$$\sum_i \sum_k C_{Rk}^{\ i} = B_R$$

The first constraint limits the faculty availability, the second constraint deals with courses and sections and the last constraint concerns research time availability. This single department formulation of the problem along linear programming lines could be extended to the entire university, taking into consideration levels of teaching, research, budgetary allocations, physical plant and equipment, space, etc. The assumption of linearity is probably not very realistic and various refinements are possible to remove this assumption. For instance, we can postulate non-linear or quadratic preference function and then attempt to determine an optimal solution. Solution procedures are not, however, readily available when the constraints are not linear, and particularly in the case of non-convexity due to increasing returns to scale.

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1) D. Winkelmann, A Programming Approach to the Allocation of Teaching Resources, a paper presented at the 1965 Meeting of the Nudwest Economics Association, Dept. of Economics, Iowa State University, Iowa, April 1965.

Professor Karl A. Fox outlined at the Conference the work developed at Iowa State University, details of which have been published(1). Two similar approaches to cost estimation were discussed at the Conference. The presentations were by Professor Anthony Bottomley on his work on costs and returns per student at the University of Bradford, and by Professor Olav A. Magnussen on the cost estimation work being undertaken in Norway. To outline both approaches would involve repetition; therefore the following extracts from Professor Magnussen's paper, "A Model for the Estimation of Current Costs at an Institution of Higher Learning", have been selected to represent the nature of the work.

In the structure of the model, $i = 1, \cdots\cdots n$ represents the different studies within a university, and $j = 1, \cdots\cdots m$ symbolises the various levels, such as college, Master's education and Ph.D. education.

The training on the different levels within a faculty is organised in groups of different size determined by the organisation of the training. The size of a group might also be influenced by the professional status of the teacher lecturing. The size of a group in faculty i on level j lectured by a teacher of category (professional status) l is denoted by k^l_{ij} where $l = 1, \cdots\cdots L$.

The number of lecturing hours given by teachers of category l (including hours of preparation) in faculty i on level j is determined structurally and denoted by h^l_{ij}. $\sum_l h^l_{ij} = h_{ij}$ is the total input of lecturing hours given by teachers of all professional categories. If we denote the number of students on level j in faculty i as S_{ij}, we can express the demand for teachers in terms of input of lecturing hours on level j in faculty i as:

$$L_{ij} = S_{ij} \cdot \frac{h^1_{ij}}{k^1_{ij}} + S_{ij} \cdot \frac{h^2_{ij}}{k^2_{ij}} + \cdots\cdots + S_{ij} \cdot \frac{h^L_{ij}}{k^L_{ij}}$$

$$L_{ij} = S_{ij} \sum_l \cdot \frac{h^l_{ij}}{k^l_{ij}}$$

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1) J.T. Sengupta and K.A. Fox, Economic Analysis and Operations Research: Optimisation Techniques in Quantitative Economic Models.

We will assume that k^l_{ij} is independent of l, such that

$k^l_{ij} = k_{ij}$ for all l. We can then write:

$$L_{ij} = \frac{S_{ij}}{k_{ij}} \sum_{\ell} h^i_{ij} = \frac{S_{ij}}{k_{ij}} h_{ij} \quad \text{or}$$

$S_{ij} = L_{ij} \cdot \frac{k_{ij}}{h_{ij}}$ as the number of students sometimes is determined by the lecturing hours available. Estimating the number of students in this way implicitly assumes that there is perfect substitution between teachers with different professional status. On many levels this is an unrealistic assumption, and the number of students admitted will then be determined by the number of lecturing hours available of each professional category.

The demand for lecturing hours by the professional category l on level j in faculty i is equal to:

$$L^l_{ij} = \frac{S_{ij}}{k_{ij}} h^l_{ij}$$

The teaching obligation for category l is p^l hours per week. The required number of teachers of category l is then equal to:

$$V^l_{ij} = \frac{L^l_{ij}}{p^l} = \frac{S_{ij}}{k_{ij}} \cdot \frac{h^l_{ij}}{p^l} = \underline{S_{ij} \cdot a^l_{ij}}$$

where $a^l_{ij} = \frac{h_{ij}}{k_{ij}} \cdot \frac{1}{p^l}$

This would be the demand for full-time teachers if there was no part-time lecturing. We assume, however, that the proportion d^l_{ij} of the total input of lecturing hours given by teachers of category l is supplied by part-time teachers. The demand for full-time teachers of category l in terms of lecturing hours is then:

$L^l_{ij} - d^l_{ij} \cdot L^l_{ij} = (1 - d^l_{ij}) L_{ij}$ where $0 \leqslant d^l_{ij} \leqslant 1$.

Thus the demand for teachers of professional status l on level j in faculty i will be:

$\underline{V^l_{ij} = a^l_{ij} (1 - d^l_{ij}) S_{ij}}$ which is equivalent to:

$$S_{ij} = \frac{V^l_{ij}}{a^l_{ij} (1 - d^l_{ij})} \qquad \begin{matrix} l = 1, \ldots\ldots\ldots\ldots L \\ i = 1, \ldots\ldots\ldots\ldots n \\ j = 1, \ldots\ldots\ldots\ldots m \end{matrix}$$

We can 'dynamise' this model by setting

$V^{lt}_{ij} = a^l_{ij} (1 - d^l_{ij}) S^t_{ij} = b^l_{ij} S^t_{ij}$ where b^l_{ij} is constant overtime. We now assume that $S_{i2} = s_{i1} \cdot S_{i1}$, i.e. we assume that a constant proportion s_{i1} of the students on level 1 proceeds to level 2, such that

$$S_{ij} = s_{i(j-1)} \cdot S_{i(j-1)}$$

Thus, $S_{ij} = S_{i1} \prod_{t=1}^{t=(j-1)} s_{it}$ and we can write:

$$V^{lt}_{ij} = S_{i1} \prod_{t=1}^{t=(j-1)} s_{it} \cdot b^l_{ij}$$

In other words, within our system the need for teachers of any category on any level will be determined by the number of students entering the first level. The model then estimates specific aspects of costs, e.g. faculty, teaching costs, student labour input costs, administrative and overhead costs, capital costs, etc. The equations dealing with the expenditure on the salaries of faculty directly related to lecturing provides an example. Wages expenditure per week for teachers of category l in facul y i is:

$$w^l_i = w^l \cdot \sum_j S_{ij} \cdot \frac{h^l_{ij}}{k_{ij}}$$

Wages expenditure for the whole staff at faculty i is:

$$W_i = \sum_\ell w^\ell_i = \sum_j \frac{S_{ij}}{k_{ij}} h_{ij} \left(\frac{h^1_{ij}}{h_{ij}} w^1 + \ldots\ldots + \frac{h^L_{ij}}{h_{ij}} w^L\right)$$

$$= \sum_j \frac{S_{ij}}{k_{ij}} \cdot h_{ij} \cdot w_{ij} \text{ where } w_{ij} = \sum_l \frac{h^l_{ij}}{h_{ij}} \; w^l$$

w^l is the wage per hour for each part-time teacher of category l.

Total wages expenditure per week for teachers directly related to lecturing is then:

$$\sum_i w_i = \sum_i \sum_j \frac{S_{ij}}{k_{ij}} \; h_{ij} \cdot w_{ij}$$

The annual expenditure when the number of lecturing weeks are denoted by U is:

$$U \sum_i \sum_j \frac{S_{ij}}{k_{ij}} \; h_{ij} \; w_{ij}$$

The value and relevance to university management of mathematical work such as Professor Magnussen's, of analytical cost exercises such as Professor Bottomley's, of resource allocation formulas such as Dr. Cottrell's, and of many other mathematical techniques do not need proving or expanding upon.

An interesting extension of the optimisation problem to economic planning - an extension which has also been carried through for university planning models - is the decomposition principle. The decomposition principle views the planning process as an iterative system using changing price signals to move the components of the plan and the plan organisation toward optimality. The principle assumes a quasi-hierarchic structure of the organisation.

The principle is also used in resource allocation models for universities with academic departments or schools being co-ordinated by a central administration(1). Take, for example, the following viewpoint:

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1) McCamley, F.P., Activity Analysis Models for Educational Institutions, unpublished Ph.D. dissertation in Iowa State University Library, Ames, Iowa, 1967, and mentioned in Karl Fox and J.K. Sengupta, op.cit., p. 689.

The university administration has at its disposal the ability to establish internal prices charged or paid for the resources consumed or produced by the various campuses or by the departments and agencies in a single complex. This decomposition procedure enables the university administration to choose that set (or sets) of prices which minimise the total cost of the system over any time span of operation(1).

In this two-level system, information flows in two directions - the centre gives guidelines and the sectors return their sub-optimal solutions - until an overall solution is reached. The model has been regarded as a control system responding to 'negative feedback'. By negative feedback we mean that behaviour of the system is modified by the margin of error of the system's output with reference to its goals. In this case, 'the shadow price system obtained by programming the sectors furnishes a feedback that achieves the continuous correction of instructions emanating from the centre'(2).

As Dr. Khan indicates in the foregoing views, universities can adapt aspects of model-building developed for national economies or industrial firms to their own needs. However, there are drawbacks and, as with the advantages, the disadvantages are not unique to educational institutions, though the degree of any particular disadvantage may be greater for a university than for an industrial firm. Dr. Khan suggests that, at the research and development level, the behavioural analysis and understanding of university decision-making has lagged behind the increasing sophistication of quantitative techniques and models. The gap can be lessened through scientific experiments which put live university members in simulated decision-making situations (e.g. business games), and through systematic decision-analysis research in real universities. The results of such experimentation and monitoring of the behavioural elements of university action should provide knowledge which can be used to improve, extend, and make more realistic the mathematical models for university planning and management.

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1) Weathersby, George, The Development and Application of a University Cost Simulation Model, Graduate School of Business Administration and Office of Analytical Studies, University of California, Berkeley, California, 15th June 1967, (mimeographed).

2) Janos Kornai, Mathematical Planning of Structural Decisions, North Holland Publishing Company, Amsterdam, 1967.

CHAPTER 8

CONCLUDING REMARKS

Universities have responded with flexibility and initiative to the quantitative pressures which have been thrust upon them in recent years; this response reflects considerable credit upon them as adaptable institutions alive to the needs of society. Thus the fact that the fundamental problems indicated in Chapter 1 remain ought not to detract from the major recent achievements of universities.

However, the accommodation of large numbers of students and other increases in scale have been able to be achieved without major changes in the management systems and practices of universities; those systems in the main are pre-industrial. The remaining problems of determining institutional mission, of reducing unit costs without lowering the quality of the output, of the more efficient planning and co-ordination of research activity, of devising curricula of continuing relevance, of harnessing the technology of education and of continuously adjusting their activities to meet changing needs and circumstances, cannot be resolved without changes in the management styles of universities. The main purposes of this book are to underline that fact, and to emphasize that each individual university has the opportunity to make those changes. Some universities have greater opportunities than others, but all institutions have some scope for management innovation. It is also true that innovations cannot be transferred as easily and uniformly amongst universities as they can amongst industrial firms or other forms of organisation. Each university has to study the innovations made elsewhere in the light of its own historical and local environment, and in the context of its own structure and objectives.

However, within those assumptions, it is highly desirable that a university should seek to learn from the experiments and developments being made in the fields of management and planning by its sister institutions. The Conference attempted to highlight a few of those developments which might encourage similar approaches in other universities. The details of the systems, processes or models being developed at California, Sussex, Toronto or Yale may not be relevant to all universities, but the attitudes and concepts underlying those developments are universally relevant.

As indicated by the experience of UIS in Germany, described in Chapter 3, external agencies can perform very important roles by encouraging and assisting individual institutions in the processes of innovation in management. There is no lack of information on those processes; both the amount of literature and the number of lines of communication to universities is increasing at a considerable rate. In most countries, however, there is a lack of training facilities and programmes for university personnel. The provision of training and re-training programmes for all categories of university personnel, whether they be Vice-Chancellors or the newest administrative recruits, is an urgent task which needs external help and pump-priming. There is also a lack of team research into the feasibilities and methods of transference of innovations amongst universities.

Within an individual university, the first objectives should be the creation of an atmosphere conducive to change, and the development of a frame of reference in which the institution is seen as an entity having purposes beyond those of factions, departments or disciplines. The achievement of these objectives can be assisted in many ways. For example, the university should take steps to make its members aware of the vital importance of universities as national and international institutions in the second half of the Twentieth Century. The roles of university institutions in the economic, social, cultural and technological development of societies and people are increasing significantly. Many members of universities seem to believe that the roles of their institutions are diminishing; if they can be convinced that the opposite is the case, and that the responsibilities and responsiveness of universities must increase as their importance grows, then the members themselves may begin to understand, accept and encourage the responsible development of institution-wide objectives and systems and the concept of continuous internal change.

Another proposition which has recurred throughout the experiences reported here is that a university should adopt a systems approach and should explicitly state and operate a comprehensive management system. A university is a system; the understanding and management of its activities cannot be properly achieved without recognition of that fact. The use of the systems analysis techniques can be maximised only when such techniques form an integral part of a total system for the management and planning of an institution. Ideally, changes even more basic than the re-structuring of management into one innovation-conducive system are required, as Herbert A. Shephard has commented(1). "There are many organisations attempting to become innovation-producers within a framework of managerial assumptions and practices which are appropriate for innovation-resisting organisations. For them the innovative processes which should be of greatest interest are ones which would help them to adopt and implement a framework more appropriate for the task. This movement requires something more basic than structural change... structural inventions can help, but if the major pre-occupations of members of the organisation are with status, with controlling others and with getting a larger slice of an unexpanding pie, these devices will not produce the desired results. The adaptability and creative application which are sought require a different outlook on life, on oneself and on others. The impact of traditional methods of education, child-rearing and organisational experience has been to develop rather complex skills for competing with others in a variety of games... Viewed from the standpoint of the lofty humanistic ideals that we from time to time proclaim, our practice is a theatre of the absurd. At the same time, our capacities for collaboration, for confrontation with ourselves and others, and for developing in ourselves and one another our full human potential have received very little attention; the rules of our organisational games discourage the development and use of these capacities. In sum, movement towards innovation-producing organisation requires processes of personal and inter-personal re-education so that more of us develop the qualities of independence and capacity for autonomous interdependence..."

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1) Herbert A. Shephard "Innovation-Resisting and Innovation-Producing Organisations", Journal of Business, University of Chicago, Vol. 40, No. 4, October 1967.

However, in the absence of facilities for that re-education, individual institutions have no option but to put their efforts into the re-structuring of processes and systems into an integrated framework.

Several chapters in this book have attempted to provide readers with a few examples of approaches to innovation from which other institutions could benefit. These innovations have at least one effect in common: they are designed to help the institution recognise its problems openly as the first step in the resolution of the problems. One test of a management system is the degree to which it forces explicit consideration of the issues which otherwise stay beneath the surface of daily crises or build up into major problems for the future. In most discussions in universities the "hidden agenda" is more important and more relevant than the written agenda; systematic management should bring these hidden agencies, questions, assumptions and attitudes into the arena of open discussion.

The advantages and disadvantages of particular techniques are a matter for each institution to assess in relation to its needs and environment. The foregoing chapters have referred to the main advantages. The main criticism of the more sophisticated techniques can be illustrated with reference to model-building. The disadvantages of model-building are: it is expensive and time-consuming, it normally has to assume that relationships, activities and trends observed in the past and the present are going to continue into the future, and it can deal only with objective and quantifiable information. In essence, although mathematical models are complex and sophisticated mechanisms, the premises upon which they are based are very much narrower than those which operate in the real situation of an institution. These present disadvantages can be outlined under three headings.

First, the construction of models is very expensive in terms of both manpower and equipment; anyone who presses for their application to a university ought to attempt to justify that application in terms of cost-effectiveness. To the author's knowledge, none of the experiments referred to in this book has been evaluated in these terms.

Secondly, the present generation of models can deal only with information, activity and objectives which can be isolated and accurately quantified and in which change can be measured. These

limitations are becoming increasingly apparent in the application of models to industrial firms, and they restrict the value of models to educational institutions where even the central activities are difficult to separate and to quantify precisely. These difficulties do not need to be described in detail. They include the fundamental one of the definition and measurement of each of the outputs of universities. Professors of Econometrics or Operational Research, who are experts in the construction of models and who are also concerned about the problems of the universities within which they work, have so far been unable to bring their specialist expertise and their institutional experience together in order to construct workable models for a university. Even if the specialists can solve the problems, such as those surrounding joint production, externalities and measurement of quality, the fact remains that an economic model is not sufficiently widely based for operational use within a university. A university is both an organisation and a community; questions of sociology, the rights of individuals, the nature of employment and work, etc., do set limits to collective action which have to be recognised by management.

Thirdly, most current models are non-dynamic in that they have to operate on the assumption that the trends of the present will continue into the future. They are not yet sufficiently flexible instruments for efficient use within a university, which is an institution that changes largely through external stimulae and incentives monitored to it by means of frequent external political decisions.

The fact that institutional model-building is not yet a device which can be used extensively in the planning and management of individual universities does not invalidate the relevance of the model-building approach to university management, particularly in the use of such techniques in limited areas of university activity. In the long run, mathematical models will become both vital and routine devices for supporting the value judgements of university management. Also, the essential advantage of the approach has immediate relevance and validity; it imposes a discipline which requires managers to be more precise in their understanding of objectives, assumptions, and relationships between activities and variables; in its simplest form

it requires managers to state and check the intuitive or mental models which they constantly use as the framework for decision-making.

The model-building approach represents one major way forward towards improving the efficiency of universities. If progress is to be made as quickly and smoothly as possible there are at least two prerequisites. First, model-building should be promoted as a development activity involving inter-disciplinary teams rather than as a pure research activity. It needs collaboration amongst the specialist experts in economics, operational research, sociology, management science, and the behavioural sciences. It needs close collaboration between the specialist managers in the areas of finance, space, academic activity, etc., particularly either to build behavioural reality into the models or to clarify the role of the model in the real situation. Such a systematic approach to model-building for educational institutions is essential since the main purpose of the model is to inculcate a systematic approach by the institution to its problems and opportunities. Secondly, the dangers of providing managers with seemingly scientific and exact information provided by the present generation of over-simplified models needs to be safeguarded against. Those dangers are real and need to be recognised by those who promote the model-building approach; there is too much at stake for the future of individual institutions for such risks to be understated. As in the case of modern medicine, science and technology generally, there are very few advances which are not also potentially dagerous. This is not a sufficient argument against pursuing those avenues for advancement, but it is a very strong argument in favour of doing so with scientific caution, and of taking steps to avoid side-effects.

The increasing rate of change must be borne in mind. The universities of the 1970s will be faced with greater increases in scale, more complex financial and social problems, increased need for internal diversification within a unified system, more complex structures and patterns of learning and research, and more intricate external relationships. In sum, their management and planning will become much more complex and much more important in its effects. In view of these changes, improved techniques will be essential for the management of universities in the 1970s. Individual institutions at this time may see the development costs and other problems associated

with rigorous techniques as a price they cannot afford in relation to the short-term benefits and the resources they have available; in these circumstances the development of approaches such as model-building should be supported through co-operative ventures or by external aid. It is through such developments that techniques may become available in time to meet the new problems of the 1970s.

In the meantime most individual institutions should tackle the more urgent problems directly concerned with the nature of their decision-making processes. If those processes are not sufficiently democratic and participative, if they over-centralise initiative rather than encourage co-ordinated devolution, if they are too rigid, if they do not clearly assign responsibility, if they fail to build in responsiveness to environmental change, and if they ignore the socio-political aspect of the nature of the institution then more sophisticated management techniques may aggravate the problems of the 1970s rather than assist in their solution.

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